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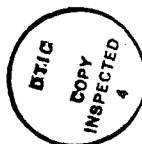
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AD-A227 652

**Installation Restoration Program
Phase II - Confirmation/Quantification
Stage 1**

*Final Report
For*

**Otis Air National Guard Base, Massachusetts
Air National Guard Support Center
Andrews Air Force Base, Maryland**

Prepared For

**United States Air Force
Occupational and Environmental Health Laboratory
(USAF OEHL)
Brooks Air Force Base, Texas
78235-5501**

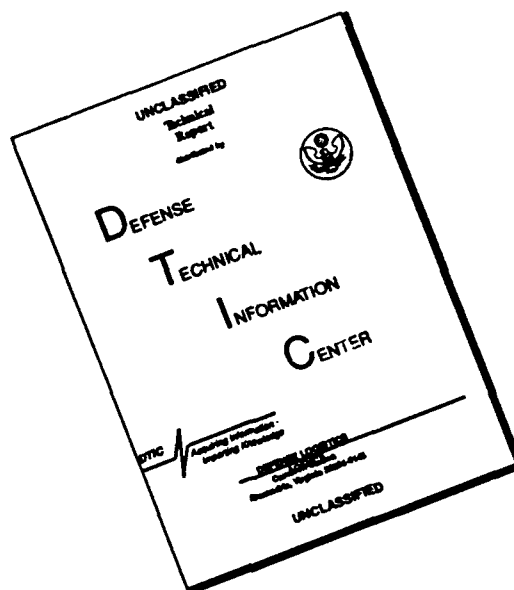
October 1985



Volume II - Appendices

HQ AFSSC (AFSSC-10)
Technical
Project
Project No. 78-00000001

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APPENDIX A

ACRONYMS, DEFINITIONS, NOMENCLATURE,
UNITS OF MEASUREMENT

SHAW



APPENDIX A

ACRONYMS, DEFINITIONS, NOMENCLATURE, UNITS OF MEASUREMENT

ANG	Air National Guard
ASTM	American Society for Testing and Materials
Anisotropy	Condition of having different properties in different directions
alluvium	sedimentary materials deposited in an environment of flowing surface waters
aquifer	zone beneath the earth's surface capable of producing water for a well
Avgas	aviation gas (fuel)
BEE	Bio-Environmental Engineering
Burnfill	Solid wastes that have been burned prior to covering or filling
CERCLA	Comprehensive Environmental Response Compensation and Liability Act of 1980
cm/s	centimeters per second
confined	an aquifer condition in which the more permeable materials are confined between two less permeable strata, and in which artesian pressures cause water to rise in wells to levels above the base of the upper confining stratum
DEQPPM	Defense Environmental Quality Program Policy
DoD	Department of Defense
feet/day	feet per day
FID/GC	Flame ionization detection/gas chromatographic techniques

groundwater divide	a theoretical dividing line in the water table on each side of which the water table slopes away, forming a boundary between separate groundwater basins
GC	gas chromatographic analytical instrument or method
gneiss	A coarse-grained, metamorphic rock consisting of banded, linearly oriented minerals
gpm	gallons per minute
gpd	gallons per day
HARM	Hazard Assessment Rating Methodology
HNu	a common brand name for a volatile organic vapor photoionization detection meter
hydraulic conductivity	ratio of flow velocity to driving force for viscous flow of water under saturated conditions in a porous medium, or volume of water that can move per unit time through a unit area of aquifer under a unit hydraulic gradient
hydraulic gradient	rate of change in pressure or hydraulic head in groundwater over a given distance of flow
IRP	Installation Restoration Program
JP-4	jet fuel
K	common symbol for hydraulic conductivity
ug/g	micrograms per gram (equal to mg/kg, and equivalent to parts per million in solids)
ug/L	micrograms per liter (equivalent to parts per billion in water)
mg/L	milligrams per liter (equivalent to parts per million in water)
mgd	million gallons per day
Mogas	motor fuel



moraine (terminal)	accumulation of mixed sediments deposited on the ice margin of a glacier
MSL	mean sea level
N	north
OANGB	Otis Air National Guard Base
OEHL	Occupational and Environmental Health Laboratory
outwash	relatively coarse, well-sorted sediment deposited by melt water streams beyond the margin of a glacier
P.G.	Registered Professional Geologist
Ph.D.	Doctor of Philosophy degree
Podzols	zonal soil having surface layer of mats of organic material overlying gray leached horizons and dark brown illuvial horizons
POL	petroleum oil and lubricants
potentiometric (piezometric) surface	surface defined by the levels to which water will rise in wells penetrating a single aquifer, caused by hydrostatic pressure
ppb	parts per billion (equivalent to ug/L in water)
ppm	parts per million (equivalent to mg/L in water)
RCRA	Resource Conservation and Recovery Act of 1976
SNARL	"Suggested No Adverse Response Level"; see 20 August 1981 EPA memo (Appendix J). A "SNARL" is a suggested guidance criterion. It is not a federally adopted drinking water standard nor has it been incorporated as a performance regulation in other federal environmental legislation



semi-confined	an aquifer condition in which the confining strata above the aquifer are not laterally continuous.
specific capacity	the sustained yield of a well divided by the drawdown in that well after a stabilized pumping condition is obtained (reported in gpm/foot).
square feet/day	square feet per day
transmissivity	the volume of water that can move through an aquifer per unit time per unit width of a saturated layer under a unit hydraulic gradient.
unconfined	an aquifer condition in which the water table forms the upper boundary
unconsolidated sediments	sediments that are uncemented and thus include interconnected void space (primary porosity) that allows storage and transmission of significant volumes of groundwater.
USAF	United States Air Force
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey, Department of the Interior
Vadose Zone	unsaturated zone above the water table; area that contains soil water under unsaturated conditions
VOA	volatile organic and aromatic hydrocarbon compounds.
water table	the level below which earth materials are saturated with water.

APPENDIX B

SCOPE OF WORK

TASK ORDER 0028-01



DEPARTMENT OF THE AIR FORCE
USAF OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (AFSC)
DOWS AIR FORCE BASE, TEXAS 78235

RECEIVED

JUL 20 1984

18 JUL 1984

REPLY TO
ATTN OF

TS

ROY F. WESTON, INC.
CONCORD OFFICE

SUBJECT

F33615-80 D-4006, Order 28, Proposed Modification 1 (IRP Stage 1, Otis ANGB)

TO

Roy F Weston
Attn: Pete Marks
Weston Way
West Chester PA 19380

1. The Government is contemplating assignment of the delivery order described in Atch 1 hereto under the subject contract. Pertinent details are included in Atch 1 and herein. Request Contractor complete paragraph 2 below within the limits set forth by Paragraph 3 below:

2. Order Prices and Other Elements:

a. Item 0001 - Hours of Effort and Prices: \$

<u>No.</u>	<u>Hours</u>	<u>Category</u>	<u>Unit Price</u>	<u>Total Price</u>
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b. Item 0002 - Support: \$

Based on the following estimates:

Sampling Bottles:
Shipping:
Travel/Per Diem:
Supplies:
Indirect Costs:
Subcontract:

c. Item 0003 (Software): N/A

3. Desired Start Date: 84 SEP 10
Estimated Completion Date: 85 DEC 30

4. Performance of this order shall not proceed until the Contractor receives a formal delivery order or verbal instructions from the Contracting Officer.

5. If the Contractor concurs with the order conditions specified, he shall so indicate by signing and forwarding two copies of this letter to USAF OEHL/TS, Brooks AFB TX 78235. If he does not agree with any of the conditions, he shall call USAF OEHL/TS to discuss proposed changes.

Emile Baladi

EMILE BALADI
Chief, Technical Services Division

1 Atch
Task Description

cc: ASD/PMRSC

APPROVED

Christopher D. Miller

CHRISTOPHER D. MILLER
Contracting Officer

The Contractor hereby concurs in the Order conditions set forth above and will perform accordingly.

Signature: _____

Title: _____

Date: _____

17 JUL 1984

INSTALLATION RESTORATION PROGRAM
Phase II Field Evaluation
Otis ANGB MA*

I. The purpose of this task is to determine if environmental contamination has resulted from waste disposal practices at Otis ANGB MA; to provide estimates of the magnitude and extent of contamination, should contamination be found; to identify potential environmental consequences of migrating pollutants; to identify any additional investigations and their attendant costs necessary to identify the magnitude, extent and direction of movement of discovered contaminants.

The presurvey report (mailed under separate cover) and Phase I IRP report (mailed under separate cover) incorporated background and description of the sites for this task. To accomplish the survey effort, the contractor shall take the following steps:

A. General

1. Determine the areal extent of each site and zone by reviewing available aerial photos of the base, both historical and the most recent panchromatic and infrared.
2. Locations where surface water samples are collected shall be marked with a permanent marker, and the location recorded on a site/zone map.
3. A total of eleven monitoring wells shall be installed. The exact location of wells shall be determined in the field.
4. Ground-water monitoring wells shall comply with U.S. EPA publication 330/9-81-002, NEIC Manual for Groundwater/Subsurface Investigations at Hazardous Waste Sites, and State of Massachusetts requirements for monitoring well installation. Only screw type joints shall be used. Glue fittings are not permitted.
5. The contractor shall not perform gravel packing of wells. Upon withdrawal of augers, formation sand shall be allowed to collapse around the screened zone. Any additional packing of the screened zone shall be done using suitable native material.
6. Wells shall be of sufficient depth to collect samples representative of aquifer quality and to intercept contaminants if they are present. Wells installed during this effort shall be constructed with 50 feet of well screen below the water table unless otherwise noted. All wells shall be developed, water levels measured, and locations surveyed and recorded on a site map.
7. All water samples shall be analyzed on site by the contractor for pH, temperature, and specific conductance. Sampling, maximum holding time,

*Highlights of modification underscored

and preservation of samples shall comply strictly with the following references: Standard Methods for the Examination of Water and Wastewater, 15th Ed. (1980), pp 35-42; ASTM, Section 11, and Methods for Chemical Analysis of Waters and Wastes, EPA Manual 600/4-79-020, pp. xiii to xix (1979). All water samples shall be analyzed using minimum detection levels, as specified in Attachment 1.

8. Field data collected for each site/zone shall be plotted and mapped. The nature of contamination and the magnitude and potential for contaminant flow within each site/zone to receiving streams and ground waters shall be determined or estimated. Upon completion of the sampling and analysis, the data shall be tabulated in the next R&D Status Report, as specified in Item VI below.

B. In addition to items delineated in A above, the contractor shall conduct the following specific actions at sites identified on Otis ANGB MA.

1. Site 1. Base Landfill

- a. Define boundaries of the landfill using a backhoe.
- b. Install four perimeter monitoring wells downgradient of this site (wells 1, 2A, 3A, 4).
- c. Perform split-spoon sampling during well drilling.
- d. Collect one ground-water sample from each well.
- e. Analyze each ground-water sample for Total Organic Carbon (TOC), Total Organic Halogens (TOX), Oil & Grease-infrared method (O&G/IR), cyanide, phenol, PCB, iron, copper, cadmium, chromium, lead, arsenic, nickel, and the Safe Drinking Water Act pesticides listed in Attachment 1.
- f. Collect a second ground-water sample from each well.
- g. Analyze the second round of samples from wells 1, 2A, 3A, and 4 for hardness, total dissolved iron, sulfate, chloride, nitrate nitrogen, Total Kjeldahl Nitrogen, ammonia nitrogen, TOC, phenol, volatile organics (VOC), xylene, methyl ethyl ketone (MEK), and methyl isobutyl ketone, and perform an infrared scan to distinguish petroleum fractions.

2. Site 2. Current Fire Training Area

- a. Perform a test pit investigation using a backhoe. Trench surfaces shall be screened for organic vapors using an Organic Vapor Analyzer (OVA) and a HNU Photoionizer (HNU). a maximum of ten soil samples shall be collected from suspect areas in the trenches.
- b. Analyze each soil sample for TOX, O&G/IR, and lead.

c. Install two monitoring wells downgradient of this site (wells 5 and 6).

d. Perform split-spoon sampling during well drilling.

e. Collect one ground-water sample from each well.

f. Analyze each ground-water sample for TOC, TOX, O&G/IR, PCB, and lead.

g. Collect a second round of samples from wells 5 and 6.

h. Analyze the second round of samples for TOC, phenol, VOC, xylene, MEK, and methyl isobutyl ketone, and perform an infrared scan to distinguish petroleum fractions.

3. Zone 1. Former Fire Training Area and NDI Shop

a. Perform a test pit investigation using a backhoe at the suspect site and adjacent swale. Trench surfaces shall be screened for organic vapors using an OVA and HNU. A maximum of six soil samples shall be collected from suspect areas in the trenches.

b. Each soil sample shall be analyzed for TOX, O&G/IR, and lead.

c. Collect one liquid and one sludge sample from the drain sump at the NDI Shop. The liquid sample shall be analyzed for TOC, TOX, O&G/IR, and lead. The sludge sample shall be analyzed for TOX, O&G/IR, and lead.

d. Install one monitoring well downgradient of this site (well 7).

e. Perform split-spoon sampling during well drilling.

f. Collect one ground-water sample from the well.

g. The ground-water sample shall be analyzed for TOC, TOX, O&G/IR, and lead.

h. Collect a second sample from the well.

i. Analyze the second sample for TOC, phenol, VOC, xylene, MEK, and methyl isobutyl ketone, and perform an infrared scan to distinguish petroleum fractions.

4. Site 3. AVGAS Fuel Test Dump Site

a. Perform a test pit investigation using a backhoe. Trench surfaces shall be screened for organic vapors using an OVA and an HNU. A maximum of four soil samples shall be collected from suspect areas in the trenches.

b. Analyze each soil sample for lead, phenol, and hydrocarbons (GC scan).

c. Install one monitoring well downgradient of this site. The screened zone shall extend a maximum of 20 feet into the uppermost saturated zone. Total well depth shall not exceed 75 feet. Well casing and screen shall be made of two-inch PVC.

d. Collect one ground-water sample from the well.

e. Analyze the ground-water sample for lead, phenol, (VOC), and hydrocarbons (GC scan).

5. Site 4. Petrol/Fuel Storage Area

a. Install one monitoring well downgradient, at the site perimeter. The screened zone shall extend a maximum of 20 feet into the uppermost saturated zone. Total well depth shall not exceed 75 feet. Well casing and screen shall be made of two-inch PVC.

b. Collect one ground-water sample from the well.

c. Analyze the ground-water sample for lead, phenol, VOC, and hydrocarbons (GC scan).

6. Site 5. Railway Fuel Pumping Station

a. Perform a test pit investigation using a backhoe. Trench surfaces shall be screened for organic vapors using an OVA and an HNU. A maximum of four soil samples shall be collected from the suspect areas in the trenches. Well casing and screen shall be made of two-inch PVC.

b. Analyze each soil sample for lead, phenol, VOC, and hydrocarbons (GC scan).

c. Install two monitoring wells downgradient of this site. The screened zone shall extend a maximum of 20 feet into the uppermost saturated zone. Total depth per well shall not exceed 75 feet. Well casing and screen shall be made of two-inch PVC.

d. Collect one ground-water sample from each well.

e. Each ground-water sample shall be analyzed for lead, phenol, VOC, O&G(IR) and hydrocarbons (GC scan).

f. Collect one liquid sample from the header pipe, and one liquid sample from the transmission pipe.

g. Analyze the two liquid samples for lead, hydrocarbons (GC scan), and base/neutrals and acids (RPA method 625).

C. Well Installation and Clean-Up

All well drill cuttings shall be removed and the general area cleaned following the completion of each well. Only those drill cuttings suspected of being a hazardous waste (based on discoloration, odor, or organic vapor detection instrument) shall be properly containerized (according to local civil engineering office requirements) by the contractor for eventual government disposal. The suspected hazardous waste shall be tested (maximum of five samples) by the contractor for EP Toxicity and Ignitability. The contractor is not responsible for ultimate disposal of the drill cuttings. Disposal will be conducted by base personnel.

D. Data Review

Results of sampling and analysis shall be tabulated and incorporated into the monthly R&D Status Reports, and forwarded to the USAF OEHL for review as soon as they become available, as specified in Item VI below.

E. Reporting

1. A draft report delineating all findings of this field investigation shall be prepared and forwarded to the USAF OEHL, as specified in Item VI below, for Air Force review and comment. This report shall include a discussion of the regional hydrogeology, well logs of all project wells, data from water level surveys, water quality analysis results, available geohydrologic cross sections, ground-water surface and gradient vector maps, any available vertical and horizontal flow vectors, and laboratory quality assurance information. The report shall follow the USAF OEHL supplied format (mailed under separate cover).

2. Estimates shall be made of the magnitude and direction of movement of contaminants discovered. Potential environmental consequences of discovered contamination shall be identified or estimated. Where survey data are insufficient to properly determine or estimate the magnitude and direction of movement of discovered contaminants, fully justified specific recommendations shall be made for additional efforts required to properly evaluate contamination migration.

3. Cost Estimates: The contractor shall provide cost estimates for all additional work recommended to permit proper determination of contaminants. The recommendations provided shall include all efforts required to determine the magnitude and direction of movement of discovered contaminants along with an estimate of the time required to accomplish the proposed effort. This information shall be provided in a separately bound appendix to the draft final report.

F. Meetings

The contractor's project manager shall attend one meeting with Air Force headquarters and regulatory agency personnel to take place at a time to be specified by the USAF OEHL. The meeting shall take place at Otis ANGB for a duration of one day (eight hours).

II. Site Location and Dates

Otis ANGB MA
102 FIW/DEE
Dates to be established

III. Base Support: None

IV. Government Furnished Property: None

V. Government Points of Contact

1. 1Lt Dulcie Weisman
USAF OEHL/ECQ
Brooks AFB TX 78235
(512) 536-3305
AV 240-3305

2. Mr. George Sundstrom -
102 FIW/DEE
Otis ANGB MA 02542
(617) 968-~~4730~~
AV 557-4730

3. Lt Col Michael Washeleski
ANGSC/SGB
Andrews AFB MD 20331
(301) 981-5926
AV 858-5926

VI. In addition to sequence numbers 1^a, 5 and 11 which are applicable to all orders, the reference numbers below are applicable to this order. Also shown are data applicable to this order.

^a
Forward a copy of the R&D Status Report to all government POCs identified in Section V.

Sequence Nr	Block 10	Block 11	Block 12	Block 13	Block 14
4*	ONE/R	84 FEB 20	<u>31 JAN 85</u>	<u>15 MAY 85</u>	*

*Contractor shall supply the USAF OEHL with 20 copies of the draft report and 50 copies plus the original camera ready copy of the final report.

	Level of Detection Required	No. of Samples ^a
TOC	1 mg/L	<u>7w</u>
TOX	5 ug/L (waters); 5 ug/g (soil)	
O&G/IR	0.1 mg/L (waters); 100 ug/g (soil)	<u>2w</u>
cyanide	10 ug/L	
phenol	1 ug/L (waters); 1 ug/g (soil)	<u>11w, 8s</u>
PCB	0.25 ug/L	
iron (total <u>dissolved</u>)	100 ug/L	<u>4w</u>
copper	50 ug/L	
cadmium	10 ug/L	
chromium	50 ug/L	
lead	20 ug/L (waters); 2 ug/g (soil)	<u>4w, 8s, 2b</u>
arsenic	10 ug/L	
nickel	100 ug/L	
endrin	0.02 ug/L	
lindane	0.01 ug/L	
methoxychlor	0.2 ug/L	
toxaphene	1.0 ug/l	
2,4-D	0.06 ug/L	
2,4,5-TP silvex	0.02 ug/L	
<u>xylene</u>	<u>1 ug/L</u>	<u>7w</u>
<u>methyl isobutyl ketone</u>	<u>1 ug/L</u>	<u>7w</u>
<u>methyl ethyl ketone</u>	<u>1 ug/L</u>	<u>7w</u>
<u>sulfate</u>	<u>1 ug/L</u>	<u>4w</u>
<u>chloride</u>	<u>1 ug/L</u>	<u>4w</u>
<u>hardness</u>	<u>--</u>	<u>4w</u>
<u>infrared scan</u>	<u>--</u>	<u>7w</u>

<u>ammonia</u>	<u>--</u>	<u>4w</u>
<u>hydrocarbon GC scan</u>	<u>--</u>	<u>4w, 8s, 2b</u>
<u>Total Kjeldahl Nitrogen</u>	<u>--</u>	<u>4w</u>
<u>nitrate</u>	<u>0.1 mg/L</u>	<u>4w</u>
<u>VOC</u>	<u>*</u>	<u>11w, 4s</u>
<u>base/neutrals and acids</u>	<u>**</u>	<u>2b</u>

NOTES:

a Applies to second round of samples at Sites 1 and 2, and Zone 1, and all samples at Sites 3, 4, and 5.

w = water s = soil b = bulk liquid

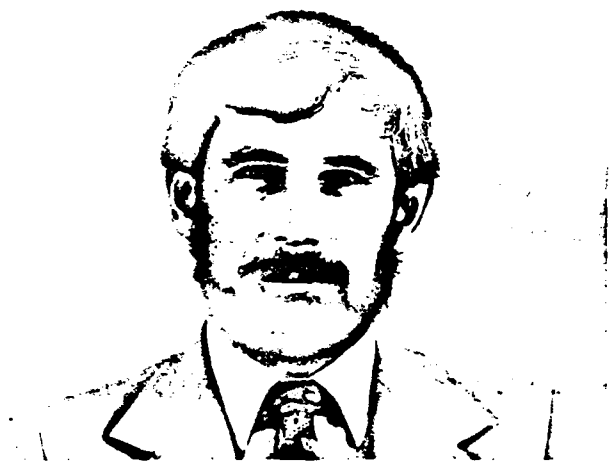
* Detection levels for volatile aromatics and volatile halocarbons shall be as specified in EPA Methods 601 and 602.

** Detection levels for base/neutrals and acids shall be as specified in EPA Method 625.

If drill cuttings are suspected of being hazardous material, five samples shall be tested for EP Toxicity and Ignitability.

APPENDIX C

BIOGRAPHIES OF KEY PERSONNEL



Peter J. Marks

Fields of Competence

Project management; environmental analytical laboratory analysis; hazardous waste, groundwater and soil contamination; source emissions/ambient air sampling; wastewater treatment; biological monitoring methods; and environmental engineering.

Experience Summary

Eighteen years in Environmental Laboratory and Environmental Engineering as Project Scientist, Project Engineer, Process Development Supervisor, and Manager of Environmental Laboratory with WESTON. Experience in analytical laboratory, wastewater surveys, hazardous waste, groundwater and soil contamination, DoD-specific wastes, stream surveys, process development studies, and source emission and ambient air testing. In-depth experience in pulp and paper, steel, organic chemicals, pharmaceutical, glass, petroleum, petrochemical, metal plating, food industries and DoD.

Applied research on a number of advanced wastewater treatment projects funded by Federal EPA.

Credentials

B.S., Biology—Franklin and Marshall College (1963)

M.S., Environmental Engineering and Science—Drexel University (1965)

American Society for Testing and Materials

Water Pollution Control Federation

Water Pollution Control Association of Pennsylvania

Employment History

1965-Present	WESTON
1963-1964	Lancaster County General Hospital Research Laboratory for Analytical Methods Development

Key Projects

USAF/OEHL Brooks AFB. Program Manager for this three-year BOA contract provides technical support in environmental engineering surveys, wastewater characterization programs, geological investigations, hydrogeological studies, landfill leachate monitoring and landfill siting investigations, bioassay studies, wastewater and hazardous waste treatability studies, and laboratory testing and/or field investigations of environmental instrumentation/equipment. Collection, analysis, and reporting of contaminants present in water and wastewater samples in support of Air Force Environmental Health Programs.

United States Army Toxic and Hazardous Materials Agency (USATHAMA), Aberdeen Proving Ground, Maryland. Program Manager for three-year basic ordering agreement contract to provide research and development for technology in support of the DOD Installation Restoration Program. The objective of the Program is to identify and develop treatment methods/technology for containment and/or remedial action. Technology development for remedial action is to include groundwater, soils, sediments, and sludges.

Confidential Client, Ohio. Project Manager of an on-going contract to conduct corporate environmental testing and special projects at client's U.S. and overseas plants. WESTON must be able to assign up to four professionals to a project within a two week notice.

Confidential Client (Inorganic and Organic Chemicals). Product Manager of a current contract to conduct wastewater sampling and analysis of plant effluent for priority pollutants. The project also includes a wastewater treatability study to evaluate a number of process alternatives for removal of priority pollutants from the present effluent.

Confidential Client, Utah. Technical Project Manager for in-depth wastewater survey, in-plant study, treatability study, and concept engineering study in support of the client's objectives to meet 1983 effluent limitations. WESTON had two project engineers, two chemists, five technicians and an operating laboratory in the field. Field effort is six months duration.

Professional Profile

In conjunction with University of Delaware College, WESTON analyzed more than 500 biological and marine sediment samples for eleven constituent trace metals as part of a program to identify and trace the migration of metals from ocean dumping of sludges on the continental shelf off the coast of the State of Delaware, acted as Technical Project Manager.

Project Manager in charge of a wastewater analysis and biological treatability project for industrial client for the identification and degradation of six pesticide-containing wastewaters.

U.S. EPA Environmental Monitoring and Support Laboratory. Multi-year contract to provide reference laboratory analysis on QA/QC samples produced from the EPA Analytical Laboratory QA/QC program.

Publications

"Microbiological Inhibition Testing Procedure," Biological Methods for the Assessment of Water Quality, A.S.T.M. Publication STP 528.

"Heat Treatment of Waste Activated Sludge" (with V.T. Stack).

"Biological Monitoring in Activated Sludge Treatment Process," a joint paper with Stover/Woldman.



Frederick Bopp III, Ph.D., P.G.

Registration

Registered Professional Geologist in the State of Indiana

Fields of Competence

Groundwater resources evaluation; hydrogeologic evaluation of sanitary landfills and other waste disposal sites; detection and abatement of groundwater pollution; digital modeling of groundwater flow and solute transport; statistical analysis of geological and geochemical data; geochemical prospecting; estuarine geology and geochemistry; trace metal and aqueous geochemistry.

Experience Summary

Seven years experience in hydrogeology and geochemistry, involving such activities as: assessment of subsurface water and soil contamination; development of contamination profiles; evaluation of remediation actions for groundwater quality restoration; quantitative chemical analysis of water and soil; ore assay and ore body evaluation; drilling supervisor; hydrogeologic assessment; pollution detection and abatement; estuarine pollution analysis; application of flow and solute transport computer models; computer programming; project management; teaching environmental geology and geochemistry.

Credentials

B.A., Geology—Brown University (1966)

M.S., Geology—University of Delaware (1973)

Ph.D., Geology—University of Delaware (1979)

Sigma Xi, The Scientific Research Society of North America

Geological Society of America, Hydrology Division

National Water Well Association, Technical Division

American Association for the Advancement of Science

Estuarine Research Federation: Atlantic Estuarine Research Society

Employment History

1979-Present	WESTON
1977-1979	U.S. Army Corps of Engineers Waterways Experiment Station
1976-1977	University of South Florida Department of Geology
1970-1976	University of Delaware Department of Geology
1974-1976	Earth Quest Associates President and Principal Partner
1974 (Summer)	WESTON
1966-1970	United States Navy Commissioned Officer

Key Projects

Project manager on seven task orders for environmental assessment services at United States Air Force facilities in nine states.

Task manager for a Superfund site evaluation in Ohio.

Site manager for drum recovery operations in Pennsylvania and New Jersey.

Project manager for site assessments of oil and fuel spills in four states.

Project manager for closure plan development at a hazardous waste landfill in New Jersey.

Definition and abatement of groundwater contamination from chemical manufacturing in Delaware.

Flow and solute transport digital model of a heavily-pumped regional aquifer in southern New Jersey.

Definition and abatement of groundwater contamination from chemical manufacturing in the Denver area.

Hydrogeologic impact assessment of on-land dredge spoil disposal in coastal North Carolina.

Geochemical prospecting and ore body analysis in Arizona.

Professional Profile

Definition and abatement of groundwater contamination from a hazardous waste site in northern New England.

Definition and abatement of groundwater contamination from plating and foundry wastes in eastern Pennsylvania.

Operational test and evaluation of new naval mine ordinances in southern Florida.

Publications

"Metals in Estuarine Sediments: Factor Analysis and Its Environmental Significance". *Science*, 214 (1981): 441-443.

"The Remobilization of Trace Metals from Suspended Sediments Entering the Delaware Estuary". Presented at the 27th Annual Meeting, Southeastern Section, Geological Society of America, Chattanooga, Tennessee, April 1978.

"Trace Metals in Delaware Bay Sediments and Oysters". Presented at the International Conference on Heavy Metals in the Environment, Toronto, Canada, October 1975.



Richard L. Kraybill

Fields of Competence

Hydrogeologic and geotechnical investigations of hazardous waste sites and landfills; evaluations of potential site use for solid and liquid waste disposal and secure land burial facilities; hydrogeologic analyses of remedial alternatives for groundwater contamination problems. Management of hydrogeologic projects involving groundwater resource evaluation, monitoring, development, and protection; analyses of groundwater quality trends as compared to land use.

Experience Summary

Fifteen years of professional experience in the field of groundwater pollution control. Expertise in providing technical guidance and advice to industry and public and governmental agencies on hydrogeologically related problems of groundwater management, protection, and development.

Prepared hydrogeologic reports assessing groundwater availability and suitability for supply; conducted investigations of groundwater pollution incidents and developed reports with specific recommendations relating to serious pollution problems and large scale water resource issues.

Coordinated and supervised subsurface exploratory work for hydrogeologic investigations relating to landfills, hazardous waste sites, groundwater injection systems, and other projects affecting groundwater; organized and performed studies utilizing advanced hydrogeologic methods such as ionic tracers, earth resistivity, and remote sensing; utilized mathematical principles of groundwater flow in hydrogeologic investigations.

Participated in planning, coordination and development of groundwater recovery and treatment projects where groundwater has been polluted.

Provided consultation and expert testimony on hydrogeologic aspects of disposal of hazardous and non-hazardous wastes. Managed group of geologists involved in hydrogeologic-geotechnical investigations.

Credentials

B.A., Geology—Lafayette College (1967)

M.S., Geology—Rutgers University (1977)

Affiliations

National Water Well Association, Technical Division

Water Pollution Control Federation

Pennsylvania Water Pollution Control Association, Eastern Section

Geological Society of America, Hydrogeologic and Engineering Divisions

Employment History

1981-Present	WESTON
1979-1981	Wehran Engineering Earth Sciences Group
1967-1979	Commonwealth of Pennsylvania

Key Projects

Senior Project Hydrogeologist on study involving the containment of PCB migration from five sites known to have received large quantities of materials containing PCB's.

Senior Project Hydrogeologist on the closure and cut-off wall certification of a large hazardous waste disposal site in a wetlands area in Michigan.

Project Manager for the hydrogeologic study and remediation analysis of a hazardous waste disposal site in Chester, PA, under contract with the PA Department of Environmental Resources and the EPA.

Developed and managed a site feasibility assessment and major detailed hydrogeologic-geotechnical investigation for the design of a secure landfill in Model City, NY.

Managed the investigation, design remediation and closure of an uncontrolled hazardous waste disposal site.

Professional Profile

Senior Hydrogeologist and Project Manager for an in-situ closure of a plating waste impoundment.

Senior Hydrogeologist for investigation and design of a secure sewage sludge disposal facility involving groundwater cutoff by slurry trench methods.

Senior Hydrogeologist for five U.S. Air Force projects developing work scopes for investigating impacts at suspect hazardous waste disposal sites under the USAF-IRP program.

At one USAF Base, performed a detailed preliminary investigation of an existing groundwater pollution problem with the objective of assessing potential impacts on a nearby public water supply resource.

Project Manager and Senior Hydrogeologist pertaining to the environmental assessment and disposal of hazardous wastes at the largest metal finishing industry in Maine. Portions of project involved evaluation, risk assessment and concept closure of a hazardous waste impoundment; EPA sludge delisting; and hazardous waste Part B applications.

Project Manager and Hydrogeologist for landfill development, closure and site permitting.

Publications

"Groundwater Quality, Variation, and Trends as Compared to Land Use in a Critical Carbonate Recharge Area." Presented at the NWWA Exposition—Technical Division Annual Meeting, Boston, Massachusetts, 1977.

"Regulatory—Technical Aspects of Sewage Sludge Disposal on the Land Surface." Presented at the Pennsylvania Water Pollution Control Association Annual Convention, 1977.

"Hydrogeologic Considerations and Remedial Alternatives Assessment at Uncontrolled Hazardous Waste Disposal Sites." Vanderbilt University-sponsored Technical Program for Environmental Protection Agency, Region V, Cincinnati, Ohio, 1981.

"In-situ Remediation and Closure of a Plating Waste Impoundment", *Toxic and Hazardous Waste*. Proceedings of the Fifteenth Mid-Atlantic Industrial Waste Conference, June 1983.



Walter M. Leis, P.G.

Registration

Registered Professional Geologist in the States of Georgia (No. 440) and Indiana.

Fields of Competence

Detection and abatement of groundwater contamination; design of artificial recharge wells; deep well disposal; simulation of groundwater systems; hydrogeologic evaluation of hazardous waste sites and landfills; practical applications of geophysical surveys to hydrologic systems, site investigations, and borehole geophysical surveys. Geochemical studies of acid mine drainage and hazardous wastes.

Experience Summary

Sixteen years experience as field hydrogeologist, field supervisor, project director, research director. Six years research involving two consecutive projects: 1) application of geophysical techniques in evaluating groundwater supplies in fractured rock terrain in Delaware and Pennsylvania; 2) project director for an artificial recharge and deep well disposal study. Provided consultation for waste disposal and aquifer quality problems for coastal communities.

Developed geochemical sampling techniques for deep mine sampling. Evaluated synthetic and field hydrologic data for deep formulational analysis in coal field projects.

Earlier research experience involved developing techniques for mapping subsurface regional structures having interstate hydrologic significance, and defining ore bodies by geochemical prospecting.

Credentials

B.S., Biochemistry—Albright College (1966)

M.S., Hydrogeology—University of Delaware (1975)

Cooperative Program Environmental Engineering—University of Pennsylvania

Additional special course work in Geology and Hydrology, Franklin and Marshall College and Pennsylvania State University

Remote Sensing Data Processing Training, Goddard Space Center (1978)

OWRR Research Fellow, 1973

National Water Well Association, Technical Division.

Geological Society of America. Engineering Geological Division.

Society of Economic Paleontologists and Mineralogists

Employment History

1974-Present	WESTON
1973-1974	University of Delaware Water Resources Center
1971-1973	University of Delaware
1967-1971	Pennsylvania Department of Environmental Resources

Key Projects

Definition of groundwater contamination from sanitary landfill leachate and recovery of contaminants to protect heavily used aquifer in Delaware.

Field design studies for artificial recharge and waste disposal wells.

Design and construction of hydrologic isolation systems for various class hazardous wastes.

Design and supervision of chemical and physical rehabilitation of groundwater collection systems in fractured rock and coastal plain areas.

Principal investigator for six projects involving subsurface migration of PCB's in New York, New Jersey, Pennsylvania, and Oklahoma.

Design and construction supervision of hydrocarbon recovery wells in Pennsylvania.

Geochemical evaluation of coal mine pools in West Virginia.

Geochemistry of subsurface migration of toxic substances.

Principal investigator for eight projects involving migration of volatile chlorinated hydrocarbons in groundwater.

Mineable reserve evaluations for coal, sand and gravel, limestone, clay deposits, mine reclamation, and monitoring.

Design geophysical and remote sensing assessments of hazardous waste disposal areas.

Publications

Leis, W., and R.R. Jordan, 1974, "Geologic Control of Groundwater Movement in a Portion of the Delaware Piedmont", OWRR—DEL 20.

Leis, W., 1976, "Artificial Recharge for Coastal Sussex County, Delaware", University of Delaware Press, Water Resources Center.

Leis, W., D.R. Clark, and A. Thomas, 1976, "Control Program for Leachate Affecting a Multiple Aquifer System, Army Creek Landfill, New Castle County, Delaware", National Conference on Management and Disposal of Residue on Land.

Leis, W., W.F. Beers, J.M. Davidson, and G.D. Knowles, 1978, "Migration of PCB's by Groundwater Transport—A Case Study of Twelve Landfills & Dredge Disposal Sites on the Upper Hudson Valley, New York", Proceedings of the 1st Annual Conference of Applied Research & Practice on Municipal and Industrial Waste.

Leis, W., R.D. Moose, and W.F. Beers, "Critical Area Maps, a Regional Assessment for Karst Topography", Association of Engineering Geologists 1978 Annual Meeting.

Leis, W., and W.F. Beers, "Soil Isotherm Studies to Predict PCB Migration Within Groundwater", (Abstract) ASTM 1979 Annual Meeting, Philadelphia, Pennsylvania.

Thomas, A., and W. Leis, "Physical & Chemical Rehabilitation of Contaminant Recovery Wells", Association of Engineering Geologists 1978 Annual Meeting.

Leis, W., W.F. Beers, and F. Benenati, "Migration of PCB's from Landfills and Dredge Disposal Sites in the Upper Hudson River Valley", New York Academy of Science Symposium on PCB's in the Hudson River.

Leis, W., "Subsurface Reclamation by Counter Pumping Systems: Geologic and Geotechnical Aspects of Land Reclamation", ASCE/AEG 1979 Symposium.

Leis, W., and A. Metry, "Field Characterization of Leachate Quality", Water Pollution Control Federation 1979 Annual Meeting.

Leis, W., and A. Metry, "Multimedia Pathways of Contaminant Migration", Water Pollution Control Federation 1980 Annual Meeting.

Leis, W., and K. Sheedy, "Geophysical Location of Abandoned Waste Disposal Sites", 1980 National Conference on Management of Uncontrolled Hazardous Waste Sites.

Sheedy, K., and W. Leis, 1982, "Hydrogeological Assessment in Karst Environments (chapter)."



James S. Smith, Ph.D.

Fields of Competence

Analytical laboratory management; organic chemistry; mass spectrometry, GC/MS/DS, high and low resolution, chemical ionization and special techniques; gas chromatography including capillary column techniques; high performance liquid chromatography (HPLC); the uses of NMR, IR, UV, visible, inorganic analyses, electrochemical, thermal techniques and surface methodologies (SEM, ESCA, SIMS) to solve industrial problems; the development of quality control measures in analytical protocols; the testing of laboratory safety methodologies; innovation of new analytical techniques and methods to solve industrial, product liability, production and environmental problems.

Experience Summary

Eleven years experience in the supervision of an analytical group involved in solving all types of industrial problems including environmental, product safety, production, research and development. The main emphasis was on the innovative development of analytical methods utilizing instrumental technologies. In-depth experience in the organic chemicals, inorganic chemicals polymer, fiber, tire, solvent, fluorine chemicals, coke and coal tar industries. Numerous scientific presentations. Contributor to three Chemical Manufacturers Association Task Groups: Environmental Monitoring, Groundwater, and Hazardous Waste Response Center.

Taught general chemistry, analytical chemistry, organic chemistry, and instrumental analysis for four years at Eastern Michigan University and the University of Illinois.

Credentials

B.A., Chemistry—Williams College (1960)

Ph.D., Organic Chemistry—Iowa State University (1964)

Postdoctoral Organic Chemistry—University of Illinois (1966)

Postdoctoral Mass Spectroscopy—Cornell University (1969)

American Chemical Society

American Society for Testing Materials

American Society of Mass Spectroscopists

Employment History

1981-Present	WESTON
1969-1981	Allied Chemical Corporation Corporate Research Center
1966-1968	Eastern Michigan University Assistant Professor of Chemistry
1965-1966	University of Illinois

Key Projects

Directed analytical group for five years of intensive sampling and analysis of a toxic insecticide. Analyses involved soil, air, water, sludge, blood, bile, feces, urine, animal feed, and plant samples to detect the compound at the low parts-per-billion level. The project involved rapid development of new and accurate analytical methods.

Developed an instrumental analytical laboratory consisting of trace environmental analyses, gas chromatography, high performance liquid chromatography, mass spectrometry, surface analyses, X-ray photoelectron spectroscopy and nuclear magnetic resonance spectroscopy including the design and manufacture of instrument modifications, purchasing instruments, and hiring of key personnel.

Isolated, identified, and developed a method of analysis for a colored impurity on a bulk chemical product. Synthesized the colorant for proof of identification and as a standard for future analysis. Proved the mechanism of the development of the color from the packaging materials. Designed new specifications eliminating the problem.

Conducted corporate plant environmental laboratory QA/QC audits including the development of a corporate QA/QC manual.

Professional Profile

Provided an inexpensive and accurate method of analysis of lead for a manufacturing plant effluent. A published methodology in kit form was modified for plant personnel use to measure soluble and total lead in a waste stream without use of excessive manpower or capital. QA/QC procedures were included as well as the use of performance samples.

Supervision of analytical technological advances that lead to either patents and new products in the fields of coal tar chemicals, food packaging and transformer manufacturing.

Publications

Smith, J., A. Weston, and C. Wezwick, "Tire Cord Emission Studies, Conclusion", The International Society of Industrial Yarn Manufacturers, Savannah, Georgia, 3-4 November 1977.

Hanrahan, J., E. McCarthy, D. Richton, J. Smith, and A. Weston, "Identification of an Interfering Compound is the Determination of Dimethylnitrosamine by Gas Chromatography-Mass Spectrometry", 26th Annual Conference on Mass Spectrometry and Allied Topics, St. Louis, Missouri, 28 May to 2 June 1978.

Brozowski, E., D. Jerolamon, D. Richton, D. Smith, J. Smith, and A. Weston, "Industrial Applications of Chemical Ionization with the Ammonium Ion", 26th Annual Conference on Mass Spectrometry and Allied Topics, St. Louis, Missouri, 28 May to 2 June 1978.

Mueller, B.W., L. Palmer, G. Rebyak, and J. Smith, "Analysis of Alpha and Beta Naphthalene Sulfonic Acids by High Performance Liquid Chromatography", North Jersey A.C.A. Chromatography Discussion Group, Nutley, New Jersey, 14 March 1979.

French, C., L. Palmer, and J. Smith, "Analysis of Polymer Oligomers by High Performance Liquid Chromatography", Middle Atlantic Regional A.C.S. Meeting, West Long Branch, New Jersey, 19-23 March 1979.

Burkitt, D. and J. Smith, "A Simple Chromatographic Modification Providing for Rapid Interchange of Capillary and Packed Columns", Middle Atlantic Regional A.C.S. Meeting, West Long Branch, New Jersey, 19-23 March 1979.

Brozowski, E., D. Jerolamon, D. Richton, D. Smith, and J. Smith, "A Convenient Method for the Evaporation of Solvent in the Priority Pollutant Program," Middle Atlantic Regional A.C.S. Meeting, West Long Branch, New Jersey, 19-23 March 1979.

Mady, N., D. Smith, J. Smith, and C. Wezwick, "The Analysis of Kepone in Biological Samples", Proceedings of the 9th Materials Research Symposium, Gaithersburg, Maryland, 10-12 April 1978.

Mueller, B., L. Palmer, and J. Smith, "A High Performance Liquid Chromatographic Method for the Analysis of Bis-phenol-A and Its Impurities", Middle Atlantic Regional A.C.S. Meeting, West Long Branch, New Jersey, 19-23 March 1979.

Gabriel, M., J. Hanrahan, and J. Smith, "A Sensitive Method for the Quantitative Analysis of Pyridine at the Low PPM Level", Middle Atlantic Regional A.C.S. Meeting, West Long Branch, New Jersey, 19-23 March 1979.

Burkitt, D., J. Hanrahan, and J. Smith, "Analysis of Hexachloroacetone and Hexafluoroacetone in Industrial Wastewater", Proceedings of the A.S.T.M. Committee D-19 Symposium, "The Measurement of Organic Pollutants in Water and Wastewater", Denver, Colorado, 19-20 June 1978.

Brozowski, E., D. Burkitt, M. Gabriel, E. McCarthy, J. Hanrahan, and J. Smith, "A Simple, Sensitive Method for the Quantitative Analysis of Carbon Tetrachloride and Chloroform in Water at the Parts Per Billion Level", Proceedings of the 9th Materials Research Symposium, Gaithersburg, Maryland, 10-12 April 1978.



Theodore F. Them, Ph.D.

Fields of Competence

Inorganic and organic chemistry; instrumental analytical techniques; synthesis of organic chemicals; laboratory management; chemical research and education.

Experience Summary

Nine years experience in inorganic and organic chemistry with strong synthetic organic and instrumental analytical background. Experienced researcher and teacher. Background in conceptualizing, founding, effecting, and administering a chemical consulting firm.

Credentials

M.S., Chemistry—University of New Mexico (1975)

Ph.D., Chemistry—University of New Mexico (1977)

American Chemical Society

The Society of Sigma Xi

Southwest Association of Forensic Scientists—Associate Member

Society of Applied Spectroscopy, Rio Grande Section

Employment History

1982-Present	WESTON
1981-1982	Bell Petroleum Services, Inc.
1982-1982	Bell Petroleum Laboratories
1977-1981	AnaChem, Inc. Co-Founder, Vice President
1975-1977	University of New Mexico

Practical Experience

Familiarity with use, maintenance, and operation of gas chromatographs with flame ionization, electron capture,

thermal conductivity, and photoionization detectors. Experience includes methods development, separation optimization, and data reduction.

Familiarity with use, maintenance, and operation of gas chromatograph/mass spectrometer/data system (GC/MS/DS) in separations and identifications of complex mixtures and molecules. Experience includes methods development, separation enhancement, packed and capillary column techniques, and data reduction.

Familiarity with use and operation of various infrared, nuclear magnetic resonance (NMR), atomic absorption (AA), and liquid chromatographic (LC) instrumentation.

Familiarity with use, maintenance, and operation of Tekmar Models LSC-2 and ALS purge/trap and liquid sample concentrator devices and associated gas chromatographic methods.

Familiarity with use, maintenance, and operation of Fisher Model 490 Coal Analyzer for analysis of moisture, volatiles and ash in coal.

Familiarity with use, maintenance, and operation of Fisher Sulfur Analyzer System for analysis of sulfur in coal and hydrocarbon fuels.

Familiarity with use, maintenance, and operation of Parr Adiabatic Bomb Calorimeter and associated Master Controller in calorimetric analysis of coal and coke, foodstuffs, and fuels.

Familiarity with use, maintenance, and operation of Fisher Models Titralyzer II (Fixed End Point) and Tritrimer II automatic titration systems for analysis of water by pH or millivolt-sensitive methods.

Publications

Hazardous Properties and Environmental Effects of Materials Used in Solar Heating and Cooling (SHAC) Technologies: Interim Handbook, J.Q. Search (ed.), August 1978. Sandia Laboratories report Sand 78-0842, available from National Technical Information Service, Springfield, Virginia.

"Isomerism in Complexes of Bidentate Ligands with Enantiotopic Donor Atoms", R.E. Tapscott, J.D. Mather, and T.F. Them, *Coordination Chemistry Reviews*, Vol. 19, Nos. 2/3, September 1979.

"Stereochemical Studies on Diastereomers of Tris (2,3-butanediamine)-Cobalt (III)", C.J. Hilleary, T.F. Them, R.E. Tapscott, *Inorganic Chemistry*, Vol. 19, No. 102, 1980.

"Staying Abreast of PCB Regulations: TESTING", R.M. Holland and T.F. Them, *Professional Trade Publication*, June 1980.

"Stereochemistry of Arsenic (III) and Antimony (III) 1,2-DihydroxyEychohexane-1,2-dicarboxylates," D. Marcovich, E.N. Duesler, R.E. Tapscott, and T.F. Them, *Inorganic Chemistry*, 1982.

EARL M. HANSEN

Credentials

B.A., Chemistry — Wittenberg University (1963)

Ph.D., Chemistry — Michigan State University (1970)

Employment History

1984-Present	WESTON
1982-1984	Envirodyne Engineers, Inc.
1977-1982	Midwest Research Institute
1973-1977	Snell Environmental Group
1972-1973	Clyde E. Williams and Associates
1969-1972	Notre Dame University

Key Projects

Managed a program to analyze environmental samples for 2,3,7,8-TCDD for the U.S. EPA. This program required the analysis of over 2,000 environmental samples in 1983.

Managed a Sampling and Analysis contract for U.S. EPA at Research Triangle Park, North Carolina. This program focused on the evaluation of a volatile organic sampling train (VOST) for the collection of volatile organic compounds from the gaseous effluents of hazardous waste incinerators. Directed the construction of two VOST trains and developed a protocol for the use of VOST to evaluate the performance of hazardous waste incinerators.

Managing EEI's laboratory Quality Assurance Program.

Participated in the design and preliminary evaluation of a laboratory-scale thermal destruction system to be used to evaluate the feasibility of incineration of liquid and solid hazardous wastes. Directed a multi-task program which required quick response methods evaluation and analysis of groundwaters and soils from hazardous waste disposal sites. Samples received in this program were analyzed for substituted phenols and polynuclear aromatic hydrocarbons (PAH's) using GC/MS and HPLC.

Managed a program to analyze process wastewaters from six organic chemical manufacturing plants. This program was

conducted for the U.S. EPA to identify and quantify the presence of organic and inorganic priority pollutants in these wastewaters. The project required design of sampling plans, development and evaluation of analytical methods, and collection and analysis of over 250 samples. These data were incorporated into the data base which is to be used by EPA to establish Best Available Treatment Technology (BAT) regulations for the organic chemical manufacturing industry.

Led the evaluation, selection, and recommendation of an inductively-coupled plasma (ICP) spectrophotometer which was purchased as an addition to MRI's atomic spectroscopy instrumentation in 1981.

Directed the completion of three projects requiring chemical analysis of air, water, and solid waste effluents which were collected from the combustion of refuse-derived fuel (RDF) as a part of an environmental assessment of waste-to-energy processes. These samples were analyzed for trace inorganic and organic components using AA, SSMS, GC, and GC/MS.

Supervised field activities for collection and shipment of wastewater samples collected from a pilot-scale wastewater treatment system in support of a treatability study of acid mine drainage conducted by the U.S. EPA.

Publications

Dalton, L.R., J.D. Rynbrandt, E.M. Hansen, and J.L. Dye, "ESR and Optical Spectra of Metal Amine and Ammonia Mixtures," J. Chem. Phys., 44, 3969 (1966).

Hentz, R.R., Farhataziz and E.M. Hansen, "Pulse Radiolysis of Liquids at High Pressures. I. Absorption Spectrum of the Hydrated Electron at Pressures up to 6.3 kbar," J. Chem. Phys., 55, 4974 (1971).

Hentz, R.R., Farhataziz and E.M. Hansen, "Pulse Radiolysis of Liquids at High Pressures. II. Diffusion Controlled Reactions of the Hydrated Electron," J. Chem. Phys., 56, 4485 (1972).

Hentz, R.R., Farhataziz and E.M. Hansen, "Pulse Radiolysis of Liquids at High Pressures. III. Hydrated Electron Reactions Not Controlled by Diffusion," J. Chem. Phys., 56, 2959 (1972).

Braswell, P., K. Guter, and E.M. Hansen, "Groundwater Monitoring Made Easy," Deeds and Data (December 1975).

Hansen, E.M., "Protocol for the Collection and Analysis of Volatile POHC's Using VOST." Prepared for Industrial Environmental Research Laboratory, Research Triangle Park, North Carolina, Contract No. 68-02-3627 (EPA-600/8-84-007, March 1984).

Papers

Dye, J.L., L.R. Dalton, and E.M. Hansen, "ESR and Optical Spectra of Metal Amine and Ammonia Mixtures," Abstracts of the 149th National Meeting of the American Chemical Society, p. 455 (April 1965).

Hentz, R.R., Farhataziz and E.M. Hansen, "Pulse Radiolysis of Liquids at High Pressures. I. Absorption Spectrum of the Hydrated Electron at Pressures up to 6.3 kbar," J. Chem. Phys., Presented at the Conference on Radiation

EARL M. HANSEN
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and Photochemistry, Whiteshell Nuclear Research Centre, Pinawa, Manitoba, Canada (November 1971).

Hentz, R.R., Farhataziz and E.M. Hansen, "Pulse Radiolysis of Liquids at High Pressures. II. Diffusion-Controlled and Nondiffusion-Controlled Reactions of the Hydrated Electron." Presented at the National Meeting of the American Chemical Society, New York (September 1972).

Cramer, P.H., E.E. Conrad, J.E. Goings, and C.L. Haile, E.M. Hansen, L.S. Malone, and A. Shan, "Analysis of Volatile Organic Priority Pollutants by the Purge and Trap Method." Presented at the Chromatography Forum, sponsored by Supelco, Inc., West Chester, Pennsylvania (May 1980).

Cramer, P.H., E.E. Conrad, J.E. Goings, and C.L. Haile, E.M. Hansen, L.S. Malone, and A. Shan, "Analysis of Volatile Organic Priority Pollutants by the Purge and Trap Method." Presented at the Meeting of the Federation of Analytical Chemistry and Spectroscopy Societies, Philadelphia, Pennsylvania (August 1980).

Ananth, K.P., P. Gorman, and E.M. Hansen, "Trial Burn Verification Program for Hazardous Waste Incineration." Presented at the 8th Annual Research Symposium for Land Disposal Incineration and Treatment of Hazardous Waste (March 1982).

Swanson, S.E., E.M. Hansen, L. Petrie, J.L. Spigorelli, and L.M. Williams, "Priority Pollutants in POTW Sludges." Presented at WPCF Conference, St. Louis, Missouri (October 1982).

Hansen, E.M., "Preparation and Analysis of Environmental Samples for 2,3,7,8-TCDD." Presented to St. Louis Section of American Chemical Society, St. Louis, Missouri (May 1982).

Hansen, E.M., "Analytical Methods for Determination of 2,3,7,8-TCDD in Soil." Presented as part of "Panel Discussion on Dioxin Risk Assessment" St. Louis Section of American Institute of Chemical Engineers (June 1983).

Hansen, E.M., "Analytical Methods for Determination of 2,3,7,8-TCDD in Soil." Presented to Chemistry Department Seminar Program, University of Missouri-St. Louis (September 1983).

CARTER P. NULTON

Fields of Competence

His graduate and post-doctoral research was directed toward the development and application of analytical methods for the study of small molecule metabolism. He was involved with the design and construction of a combined, computerized radio-gas chromatograph/mass spectrometer (RGC/MS) and its application to metabolic studies in fungi, plants and algae. For seven years at Southwest Research Institute he worked on developing methods for analysis of trace levels of organic pollutants in a variety of environmental matrices, characterizing potentially toxic organic constituents resulting from combustion processes and developing approaches to analyzing hazardous wastes. As manager of the GC/MS facility at Southwest Research Institute he also supported research in organic synthesis, fuel characterization, electronic component failure analysis and biochemistry.

Credentials

B.S., Chemistry — Geneva College (1969)

Ph.D., Biochemistry — University of Pittsburgh (1975)

Employment History

1984-Present	WESTON Organic Laboratory Manager
1978-1984	Southwest Research Institute Manager, Mass Spectrometry
1975-1978	University of Pittsburgh Research Associate

Key Projects

Development of GC methods for the analysis of industrial process waters and effluents using a wide variety of detectors (ECD, Hall, PID, FID, NPD, TCD, FPD).

Characterization of organic pollutants in municipal sludges using GC/MS.

Analysis of biota and sediments from an oil producing area in the Central Gulf of Mexico to determine the presence and extent of contamination of petrogenic hydrocarbons.

CARTER P. NULTON
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Characterization of organic wastes generated by the organobromine industry.

Studies to elucidate the mechanism(s) of sediment formation in diesel fuel using pyrolysis capillary GC/MS and FT-IR.

Sampling and analysis of feedstocks, emissions and wastes from a coal/refuse co-fired power plant with emphasis on determining if chlorinated pollutants (particularly dioxins) were evolved.

Analysis of combustion products arising from halocarbon polymers.

Abstracts

Carter P. Nulton

1. M. Campbell, E. W. Grotzinger, J. Naworal and C. P. Nulton. A New Approach to Biosynthetic Studies. 9th IUPAC International Symposium on the Chemistry of Natural Products, Ottawa, 1974, Abstract C27.

C. Nulton and I. M. Campbell. Secondary Metabolism in Penicillium brevicompactum. 7th Central Regional Meeting of the American Chemical Society, Morgantown, West Virginia, 1975, Abstract 109.

C. P. Nulton, J. D. Naworal and I. M. Campbell. A combined Radio Gas Chromatograph/Mass Spectrometer (RGC/MS) Detects Intermediates in Mycophenolic Acid Biosynthesis. 24th Annual Conference on Mass Spectrometry and Allied Topics, American Society for Mass Spectrometry, San Diego, California, 1976, Abstract PSA16.

I. M. Campbell, D. L. Doerfler, L. Ernst and C. P. Nulton. Radiogas Chromatography/Mass Spectrometry. 69th Annual AOCS Meeting, St. Louis, Missouri. J. Am. Oil Chem. Soc. 55:249A, 1978, Abstract 130.

C. F. Rodriguez, C. P. Nulton and W. A. McMahon. GC/MS Verification of Identity of Chlorinated Pesticides and Biphenyls in Municipal Sewage Treatment Plant Sludge. 27th Annual Conference on Mass Spectrometry and Allied Topics, Seattle, Washington, 1979, Abstract RAMOC9.

Charles F. Rodriguez, Donald E. Johnson, Carter P. Nulton. The Application of Wastewater Screening Methods to the Determination of Chlorination Pesticides and Biphenyls in Treatment Plant Sludge. Presented at 35th Southwest Regional ACS Meeting, Austin, Texas, 1979.

J. W. Rhoades and C. P. Nulton. Microextraction as an Approach to the Analysis of Priority Pollutants in Wastewaters. ACS Second Chemical Congress of North America Continent, San Francisco, California, 1980, Abstract 49.

J. W. Rhoades and C. P. Nulton. Priority Pollutant Analyses of Industrial Wastewaters Using a Microextraction Approach. 7th Annual Meeting Federation of Analytical Chemistry and Spectroscopy Societies, Philadelphia, Pennsylvania, 1980, Abstract 19.

C. P. Nulton and J. W. Rhoades. Microextraction Procedure: Modification and Application to Priority Pollutant Analysis in Waste Streams. 7th Annual Meeting Federation of Analytical Chemistry and Spectroscopy Societies, Philadelphia, Pennsylvania, 1980, Abstract 20.

C. P. Nulton and H. S. Silvas. Indoor Contaminants - Characterization and Detection. Presented at the Human Productivity Workshop - NASA, Ames Laboratory, California, 1984.

Publications

Carter P. Nulton

C. P. Nulton. Secondary Metabolism in Penicillium brevicompactum. Ph.D. Thesis, University of Pittsburgh, Pittsburgh, Pennsylvania, 1975.

C. P. Nulton, J. D. Naworal, I. M. Campbell and (in part) E. W. Grotzinger. Combined Radio Gas Chromatography/Mass Spectrometry Detects Intermediates in Mycophenolic Acid Biosynthesis. *Analytical Biochemistry*, 75:219-233, 1976.

C. P. Nulton and I. M. Campbell. Mycophenolic Acid is Produced During Balanced Growth of Penicillium brevicompactum. *Cand. J. Microbiol.*, 23:20-27, 1977.

I. M. Campbell, D. L. Doerfler, S. A. Donahey, R. Kadlec, E. L. McGandy, J. D. Naworal, C. P. Nulton, M. Venza-Raczka, and F. Wimberly. A Software Package to Collect and Process Radiogas Chromatographic Data. *Analytical Chem.*, 49:1726-1734, 1977.

C. P. Nulton and I. M. Campbell. Labelled Acetone and Levulinic Acid Are Formed When C-Acetate is Being Converted to Mycophenolic Acid in Penicillium brevicompactum. *Cand. J. Microbiol.*, 24:199-201, 1978.

D. L. Doerfler, C. P. Nulton, C. D. Bartman, F. J. Gottlieb, and I. M. Campbell. Spore Germination, Colony Development, and Secondary Metabolism in Penicillium brevicompactum: A Radiogas Chromatographic and Morphological Study. *Cand. J. Microbiol.*, 24:1490-1501, 1978.

J. W. Rhoades and C. P. Nulton. Priority Pollutant Analyses of Industrial Wastewaters Using a Microextraction Approach. *J. Environ. Sci. Health*, A15(5):467-484, 1980.

C. P. Nulton and D. E. Johnson. Aromatic Hydrocarbons in Marine Tissues from the Central Gulf of Mexico. *J. Environ. Sci. Health*, A16(3):271-288, 1981.

C. A. Bedinger and C. P. Nulton. Analysis of Environmental and Tar Samples from the Nearshore South Texas Area After the IXTOC-1 Blowout. *Coastal Research*, p. 19-22, October 1981.

J. W. Rhoades and C. P. Nulton. Microextraction as an Approach to Analysis for Priority Pollutants in Industrial Wastewater. In: *Advances in the Identification and Analysis of Organic Pollutants in Water*, Vol. 1, Chapter 15, L. H. Keith, ed., Ann Arbor Science Publishers, Inc., Ann Arbor, Michigan, 1981, pp. 241-252.

C. A. Bedinger and C. P. Nulton. Analysis of Environmental and Tar Samples from the Near-Shore South Texas Area after Oiling from the IXTOC-1 Blowout. *Bull. Env. Contam. and Toxcol.*, 28:166-171, 1982.

C. P. Nulton, C. L. Haile and D. P. Redford. Determination of Total Organic Halogen in Environmental Extracts Using Gas Chromatography with Hall Detection. *Anal. Chem.*, 54:598-599, 1984.

H. J. Harding, C. P. Nulton and O. Saenz, Jr. The Effect of High Inorganic Chloride Levels on TOX Determination. Submitted to *Anal. Chem.*



Glenn R. Smart

Fields of Competence

Hydrogeologic investigations of potential hazardous waste sites and landfills; design and supervision of installation of groundwater monitoring programs; collection of field data and evaluation of potential environmental impact; management of hydrogeologic projects at hazardous waste sites.

Experience Summary

Seven years of experience in various aspects of the water resource industry. Involvement in over 100 hazardous waste projects in sixteen states. Development of hazardous waste site preliminary assessments and full field investigations. Development of site safety plans for use during hazardous waste site evaluations. Fully trained in the use of respiratory protective equipment, emergency first aid procedures, site sampling protocols and chain-of-custody procedures, and general site safety programs. Frequent interaction with government and industrial clients. Provided expert testimony for super-fund litigation.

Employed remote sensing techniques and on-site investigations to locate favorable sites for the development of groundwater supplies. Collected field data, compiled hydrologic and hydraulic input, prepared reports for flood insurance studies. Presented study results to federal, state and local authorities.

Credentials

B.S., Hydrology—University of New Hampshire (1977)
National Water Well Association, Technical Division
American Water Resource Association

Employment History

1984-Present	WESTON
1979-1984	Ecology and Environment, Inc.
1977-1979	Sverdrup & Parcel and Associates, Inc.

Key Projects

Project Manager for Superfund site hydrogeologic investigation to determine potential impact on local well water supplies.

Project Manager for complete hydrogeologic investigation of Superfund site involving alleged contamination of municipal field.

Project Manager for confidential industrial client. Project included hydrogeologic study to determine the groundwater quality beneath site slated for industrial development.

Supervised a team of six field geologists and participated in collection of geologic data for nationwide mineral survey. Responsible for all planning, logistics, quality assurance and financial control of the team.

Designed shallow water table study to assess impact of past waste disposal practices of confidential client.

Designed and supervised installation of numerous groundwater monitoring programs at hazardous waste sites.

Publications

Hagger, C.L.D., and G.R. Smart, "Drilling and Installation of Groundwater Monitoring Wells on Hazardous Waste Sites: Construction Specifications and Preparations for Non-ideal Field Conditions." Paper presented to Northeast Conference on the Impact of Waste Storage and Disposal on Groundwater Resources, Ithaca, New York, July, 1982.

Smart, G.R., "A Cost-Effective Approach to Monitoring Well Installation." Paper presented to Triangle Conference on Environmental Technology, University of North Carolina at Chapel Hill, North Carolina, April, 1983.

Smart, G.R., "Installation of Monitoring Wells at Hazardous Waste Sites." Paper presented to 1983 Spill Control and Hazardous Materials Conference, New Haven, Connecticut, 1983.

Smart, G.R., "Design of Monitoring Well Systems to Meet RCRA Requirements." Presented at the HMCRI Waste Site Conference, Houston, Texas, March, 1984.

Professional Profile

Steven I. Michelson

Registration

Engineer-In-Training

Fields of Competence

Field investigations; groundwater resource evaluations; hydrogeologic investigations of landfills and potential water resource impacts; geologic mapping; regional and local structural and geomorphological analyses; microscopic identification of minerals; foundation and structural concrete design; surveying; analysis of soil stability and mechanics; small systems analysis and design; CPM generation; Fortran IV program design and analysis.

Employment History

1983-Present	WESTON
1982	Getty Refining and Marketing
1981	Geological Mapping and Interpretation Wyoming-Idaho Rockies

Credentials

B.S., Geology—Lehigh University (1982)

B.S., Civil Engineering—Lehigh University (1982)

Key Projects

Assisted in the evaluation of contaminant migration to a future Bedford, Massachusetts well-water site as part of a U.S. Air Force-sponsored project at Hanscom Field.

Technical supervision and participation in the scheduled operation and disassembly of pilot treatment plant. Conducted sampling and field studies in support of pilot treatment unit.

Participated in procedural design and operation of field sampling and analysis of a chemical waste impoundment.

Assisted in design and evaluation for fresh water storage in Lincoln, New Hampshire. Organized written and plan specifications for contract bidding.

Assisted in the evaluation of the environmental impact of present landfill leachate and seepage.

Conducted site design, evaluation, and construction cost estimations for wastewater treatment plant in North Andover, Massachusetts.

APPENDIX D

WELL AND TEST PIT LOGS

APPENDIX D-1

BORING LOGS



TEST BORING LOG
BORING NO. RFW-1

PROJECT: IRP - OTIS ANGB PHASE II FIELD INVESTIGATION
CLIENT: USAF
BORING CONTRACTOR: D.L. MAHER

SHEET NO 1 OF 3
JOB NO.
ELEVATION

GROUND WATER:				CAS.	SAMP.	CORE	TUBE
DATE	TIME	WATER EL.	SCREEN	TYPE	SS		
12-6	1:00	70'-10"	50'-0.010	DIA.	2"		
				WT.	140		
				FALL	30"		

DATE STARTED 12-6-83
DATE FINISHED 12-8-83
DRILLER W. CANTY
INSPECTOR D. WOODHOUSE

WELL CONSTRUCTION 41" S.U.		SAMPLE			CLASSIFICATION BURMISTER	REMARKS
	DEPTH FEET	NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS	0				OUTWASH DEPOSITS	
	5					
	10	S-1	SS	9-12 16-23	Gray Silt and fine to coarse SAND trace Gravel — — grading to — —	medium dense
	15				Brown fine to coarse SAND trace Gravel trace Silt	
	20	S-2	SS	14-15 10-11	Brown (oxidized) fine to coarse SAND some Gravel trace Silt	medium dense
	25					
	30	S-3	SS	5-7 9-13	similar	
	35					
	40	S-4	SS	8-10 12-12	similar	
	45					
BLANK SCH 80					D1-1	



TEST BORING LOG

BORING NO. RFW-1

PROJECT: IRP OTIS ANGB PHASE II

SHEET NO. 2 OF 3

CLIENT: USAF

JOB NO.

WELL CONSTRUCTION		DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
			NO.	TYPE	BLOWS PER 6 INCHES		
O U T W A S H D E P O S I T S	BENTONITE GROUT 2" O.D. BLANK SCH 80	45					
		50	55	SS	6-9 10-14	Gray-brown to rust-brown fine to coarse SAND + trace Silt little Gravel	medium dense
		55					
		60	56	SS	5-7 11-13	similar	
		65					
		70	57	SS	3-15 12-20	Gray-brown fine to medium SAND grading to oxidized brown \approx 70' fine to coarse SAND trace Gravel, Silt	medium dense saturated at bottom
		75					
		80	58	SS	8-9 14-14	Gray-brown fine to coarse SAND trace Gravel trace Silt	
		85					
		90	59	SS	5-8 7-9	similar	
FORMATION SAND COLLAPSE	SCREEN 1" O.D.	95					





TEST BORING LOG -
BORING NO. RFW-2A

PROJECT : IRP OTIS ANGB PHASE II

CLIENT : USAF

BORING CONTRACTOR : D.L. MAHER

GROUND WATER :

DATE 1-27 TIME 1400 WATER EL. 70' 9"

SCREEN 50'

TYPE DIA.

WT.

FALL

SHEET NO 1 OF 1

JOB NO.

ELEVATION

DATE STARTED 1-27-84

DATE FINISHED 1-28-84

DRILLER W. CANTY

INSPECTOR D. WOODHARSE

WELL CONSTRUCTION	DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
BENTONITE and SAND ↑ BENTONITE 6" GROUT 55 GAL. ↓ FORMATION SAND ↑ SCREEN 0.010" 2" O.D.	0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570 580 590 600 610 620 630 640 650 660 670 680 690 700 710 720 730 740 750 760 770 780 790 800 810 820 830 840 850 860 870 880 890 900 910 920 930 940 950 960 970 980 990 1000				LOCATED 30 FT SOUTH OF RFW-2 NO SAMPLES TAKEN DEVELOPED 2/1/84	



TEST BORING LOG

BORING NO. RFW-2

PROJECT: IRP OTIS ANGR PHASE II

SHEET NO. 2 OF 3

CLIENT: USAF

JOB NO.

WELL CONSTRUCTION		SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS	BENTONITE GROUT ↓ FORMATION SAND COLLAPSE				medium to coarse SAND little fine Gravel	loose dry
		5	SS	4-6 12-13		
					Similar	
		6	SS	8-13 15-15		
					Similar ∇ 70'2"	moist
		7	SS	8-11 17-20		
					Similar	saturated
		8	SS			
					Similar	
		9	SS	10-14 15-19		



TEST BORING LOG
BORING NO. RFW-2

PROJECT: IRP OTIS ANGR PHASE II
CLIENT: USAF

SHEET NO. 3 OF 3
JOB NO.

WELL CONSTRUCTION		SAMPLE			CLASSIFICATION	REMARKS
	DEPTH FEET	NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS SCREEN 12" O.D. SCH 80 10.020" I.D. CORROSION RESISTANT	98				Medium to coarse SAND little fine Gravel	
		10	SS	3-5 8-14		
	100					
					Similar	
		11	SS	2-8 10-16		
	110					
					Similar	
		12	SS	3-4 9-11		
	120					
					Bottom of Hole	
	120'					



TEST BORING LOG
BORING NO. RFW-3A
SHEET NO 1 OF 1
JOB NO.
ELEVATION

PROJECT : IRP OTIS ANGB PHASE II
CLIENT :
BORING CONTRACTOR :

GROUND WATER :				CAS.	SAMP.	CORE	TUBE
DATE	TIME	WATER EL.	SCREEN	TYPE			
1-30	0730	79' 8"	50'	DIA.			
				WT.			
				FALL			

DATE STARTED 1-28-84
DATE FINISHED 1-30-84
DRILLER W. CANTY
INSPECTOR D. WOODHOLSE

WELL CONSTRUCTION	DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
BENTONITE and SAND 2" O.D. SCH 40 BLANK GROUT 55 gal. FORMATION SAND SCREEN 1/8" O.D. 2" O.D.	0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300				RFW-3A LOCATED 30' WEST OF RFW-3 NO SAMPLES TAKEN DEVELOPED JAN 30, 1984	



TEST BORING LOG
BORING NO. RFW-3

PROJECT: IRP OTIS ANGEL PHASE II

SHEET NO. 2 OF 3

CLIENT: USAF

JOB NO.

WELL CONSTRUCTION		SAMPLE			CLASSIFICATION	REMARKS
	DEPTH IN FEET	NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS	0				Tan medium to coarse SAND little fine to medium Gravel	loose damp
	2	5	SS	9-10 10-17		
	30					
	35					
	40	6	SS	5-11 15-18	similar	
	50					
	60					
	70	7	SS	8-11 14-15	similar	
	80					
	90	8	SS	10-11 10-20	similar	saturated
SCREEN 0.075"	100					
	110					
	120					
	130					
	140					
	150					
	160					
	170					
	180	9	SS	7-8 12-18	similar	
	190					
D1-10						



TEST BORING LOG
BORING NO. RFW-3

PROJECT: IRP DTIS ANGB PLASE II

SHEET NO. 3 OF 3

CLIENT: USAF

JOB NO.

WELL CONSTRUCTION	DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS FORMATION SAND COLLAPSE SCREEN SCH 80	0				Tan medium to coarse SAND little fine to medium Gravel	
	10	10	SS	7-16 17-20		
	20					
	30				Similar	
	40	11	SS	3-8 11-14		
	50					
	60				Similar	
	70	12	SS	4-7 9-12		
	80					
	90				Similar	
	100	13	SS	3-5 7-11		
	110					
	120				Bottom of hole	

D1-11



TEST BORING LOG

BORING NO. RFW-4

PROJECT: ICP OTIS ANGR PHASE II

CLIENT: USAF

SHEET NO 1 OF 3

BORING CONTRACTOR: D.L. MAHER

JOB NO.

GROUND WATER:

ELEVATION

DATE	TIME	WATER EL.	SCREEN	CAS.	SAMP.	CORE	TUBE	DATE STARTED	DATE FINISHED	DRILLER	INSPECTOR
								12-22-83	1-10-89	W. CANTY	S. MICHELSON
											D.E. EPPS

WELL CONSTRUCTION			SAMPLE			CLASSIFICATION	REMARKS
	DEPTH FEET		NO.	TYPE	BLOWS PER 6 INCHES		
O O T W A S H S I S P O O D S I S BLANK	2" O.D. SCH 80	ENTOMETER AND SAND				OUTWASH DEPOSITS Tan fine to coarse SAND little Gravel similar similar similar	Loose
			1	SS	6-8 8-8		
			2	SS	3-7 8-9		
			3	SS	5-10 11-15		
			4	SS	7-9 14-18		



TEST BORING LOG
BORING NO. RFW-4
SHEET NO. 2 OF 3
JOB NO.

PROJECT: IRP OTIS ANG B PHASE II
CLIENT: USAF

WELL CONSTRUCTION	DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
O U T L I N E S C H 8 0 2" O.D. BLANK S C R E E N 10.020" 2" O.D.	48					
	50	5	SS	8-9 14-20	Tan fine to coarse SAND little Gravel	Loose
	52					
	54					
	56	6	SS	7-10 15-21	Similar	
	58					
	60					
	62					
	64					
	66	7	SS	5-12 12-10	similar	
	68					
	70					
	72					
	74					
	76					
	78					
	80	8	SS	5-7 10-11	similar	
	82					
	84					
	86					
	88					
	90	9	SS	4-9 10-14	similar	
	92					
	94					
	96					
	98					
	100					



TEST BORING LOG

BORING NO. RFW-4

PROJECT: IRP OTIS ANGE PHASE II

SHEET NO. 3 OF 3

CLIENT: USAF

JOB NO.

WELL CONSTRUCTION	DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS FORMATION SAND COLLAPSED SCREEN 0.020" SCH 80	95				Tan fine to coarse SAND little Gravel similar Bottom of Hole 118'	Loose
		10	SS			
	96					
	97					
		11	SS			
	98					
	99					
		12	SS			
	100					
	101				D1-14	
	102					
	103					
	104					
	105					
	106					



TEST BORING LOG
BORING NO. RFW-5

PROJECT: IRP OTIS ANGB PHASE II

SHEET NO. 2 OF 3

CLIENT: USAF

JOB NO.

WELL CONSTRUCTION		SAMPLE			CLASSIFICATION	REMARKS
	DEPTH FEET	NO.	TYPE	BLOWS PER 6 INCHES		
USATECO BLANK 2" O.D. SAND COLLAPSE SCREEN SCH 80	0					
	1					
	2					
	3					
	4					
	5	5	SS	6-9 13-13	Light-brown fine to coarse SAND little Gravel	saturated
	6					
	7	6	SS	7-7 12-15	Similar	
	8					
	9					
	10	7	SS	4-6 9-10	similar	
	11					
	12					
	13					
	14					
	15	8	SS	7-9 7-14	similar	
	16					
	17					
	18	9	SS	6-8 9-14	similar	
	19					
	20					
	21					
	22					
	23					
	24					
	25					
	26					
	27					
	28					
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	98					
	99					
	100					



TEST BORING LOG
BORING NO. RFW-5
SHEET NO. 3 OF 3
JOB NO.

PROJECT: TRP OTIS ANGB PHASE II
CLIENT: USAF

WELL CONSTRUCTION	DEPTH IN FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
OBTAIN QUANTITY SCREEN 11.0.0.20" FORMATION SAND	0				light brown fine to coarse SAND little Gravel	
	10	SS				
	20					
	30					
	40					
	50					
	60					
	70					
	80					
	90					
	100				BOTTOM OF HOLE 105'	
	110					
	120					
	130					
	140					
	150					
	160					
	170					
	180					
	190					



TEST BORING LOG

BORING NO. RFW-6

PROJECT : IRP OTIS ANGB PHASE II

SHEET NO 1 OF 3

CLIENT : USAF

JOB NO.

BORING CONTRACTOR : D.L. MAHER

ELEVATION

GROUND WATER :

DATE	TIME	WATER EL.	SCREEN	TYPE	CAS.	SAMP.	CORE	TUBE
				DIA.		SS		
				WT.		140		
				FALL		30"		

DATE STARTED 1-10-84

DATE FINISHED 1-10-84

DRILLER W. CANTY

INSPECTOR D.E. EPPS

WELL CONSTRUCTION		DEPTH IN FEET	SAMPLE			CLASSIFICATION	REMARKS
			NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS	BENTONITE and SAND 2" O.D.	0				OUTWASH DEPOSITS Light brown fine to coarse SAND little Gravel Similar similar similar	
		2					
		4					
		6					
		8					
		10	1	SS	9-10 10-10		
		12					
		14					
		16	2	SS	4-5 8-9		
		18					
		20					
		22					
		24					
		26					
		28	3	SS	6-7 13-17		
		30					
BLANK	SCH 80 6 INCH GROUT SS	32					
		34					
		36					
		38					
		40					
		42					
		44					
		46					
		48					
		50	4	SS	3-5 7-8		
		52					
		54					
		56					
		58					
		60					
		62					
		64					
		66					
		68					
		70					



TEST BORING LOG

BORING NO. RFW-6

PROJECT: IRP OTIS ANGB PHASE II

SHEET NO. 2 OF 3

CLIENT: USAF

JOB NO.

WELL CONSTRUCTION		SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
OUTWASH DEPOSITS	2" O.D. BLANK	FORMATION	↓			
				5	SS 4-5 8-12	Light brown fine to coarse SAND little Gravel
				6	SS 2-3 5-7	similar
SAND COLLAPSE	2" O.D. SCREEN	SAND	↓			
				7	SS 3-6 20-12	similar
				8	SS 2-3 3-8	similar
SAND COLLAPSE	2" O.D. SCREEN	SAND	↓			
				9	SS 2-3 3-8	Light brown fine to coarse SAND

TEST BORING LOG
BORING NO. RFW-6

PROJECT: IRP OTIS ANGB PHASE II

SHEET NO. 3 OF 3

CLIENT: USAF

JOB NO.

[illegible]

TEST BORING LOG
BORING NO. RFW-7

PROJECT : IRP OTIS ANGB PHASE II

SHEET NO / OF 2

CLIENT : USAF

JOB NO.

BORING CONTRACTOR : D. L. MAHER

ELEVATION

GROUND WATER:

DATE	TIME	WATER EL.	SCREEN	TYPE	ORG.	SMALL	COND.	TEMP.
				DIA.				
				WT.				
				FALL				

DATE STARTED 1-9-84

DATE FINISHED 1-9-84

DRILLER W. CANTY

INSPECTOR DEEPPS

WELL CONSTRUCTION		DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS												
			NO.	TYPE	BLOWS PER 6 INCHES														
O T E A S I S T S O O S T S	B E N T O N I T E A N D S A N D	2" O.D.	SCH 80	G R O U T	CORROSION	S A N D				OUTWASH DEPOSITS									
										</									



TEST BORING LOG

BORING NO. RFW-7

PROJECT: IRP OTIS ANGB

PHASE II

SHEET NO. 2 OF 2

CLIENT:

JOB NO.

WELL CONSTRUCTION		SAMPLE			CLASSIFICATION	REMARKS	
	DEPTH FEET	NO.	TYPE	BLOWS PER 6 INCHES			
OUTWASH DISPOSITS	FORMATION SAND COLLAPSE SCREEN 80" 1				Light brown fine to coarse SAND little Gravel	Saturated	
		5	SS	5-5 9-12			
							Similar
		6	SS	2-6 7-10			
					Similar		
		7	SS	2-3 6-7			
							Similar
		8	SS	3-4 8-8			
					Similar		
		9	SS	4-6 8-10			
							90'
		Bottom of hole					
		DI-22					



TEST BORING LOG
BORING NO. RW 8

PROJECT : IRP - OTIS ANG B PHASE II - MODIFICATION

SHEET NO. 1 OF 2

CLIENT : USAF

JOB NO. 0628-05-22

BORING CONTRACTOR : D.L. MAHER

ELEVATION

GROUND WATER:

DATE	TIME	WATER EL.	SCREEN	TYPE	CAS.	SAMP.	CORE	TUBE
				DIA.		SS		
				WT.		2"		
				FALL		140		
						30"		

DATE STARTED 10/9/84

DATE FINISHED 10/10/84

DRILLER W. DAVIS

INSPECTOR G. SMART

WELL CONSTRUCTION		DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
			NO.	TYPE	BLOWS PER 6 INCHES		
CONCRETE CAP		0	S-1	SS	1-1-1-1	TOP SOIL	HNu - BACKGROUND
		5				OUTWASH	
SCHEDULE 80 2" ID PVC RISER BENTONITE AND SAND GROUT		10	S-2	SS	4-7-16-17	TAN COARSE SAND, some medium to coarse gravel	
		15					
		20	S-3	SS	5-5-7-8	SIMILAR WITH fine gravel	HNu - BACKGROUND
		25					
		30	S-4	SS	3-5-6-9	TAN MEDIUM TO COARSE SAND, trace fine to medium gravel	DAMP
	PURE BENTONITE	35					
		40	S-5	SS	4-6-9-10	SAME	DAMP TO WET
		45					
	NATIVE SAND BACKFILL						
						D1-23	▼ GROUNDWATER - 43'



TEST BORING LOG

BORING NO. RFW 9

PROJECT: IRP- OTS ANGE PHASE II - MODIFICATION

SHEET NO. 2 OF 2

CLIENT: U.S.A.F.

JOB NO. 0628-05-28

WELL CONSTRUCTION		DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
			NO.	TYPE	BLOWS PER 6 INCHES		
SCREEN 0.01" NATIVE SAND BACKFILL		45				SAME	SATURATED
		50	56	SS	33-7-8		
		55					
		60					
		65	57	SS	3-4-6-8		
		70				SAME, more gravel BOTTOM OF HOLE	
		75					
		80					
		85					
		90					
		95					

D1-24

PROJECT : ZRP - OTIS ANGE PHASE II - MODIFICATION

SHEET NO 1 OF 2

CLIENT : USAF

JOB NO. 0628-OS-28

BORING CONTRACTOR : D.L. MAHER

ELEVATION

GROUND WATER :

DATE	TIME	WATER EL.	SCREEN	CAS.	SAMP	CORE	TUBE
					SS		
					2"		
					140		
					30"		

DATE STARTED 10/10/64

DATE FINISHED 10/11/64

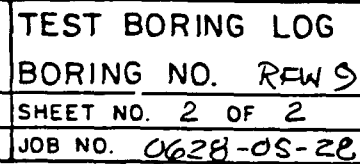
DRILLER W. DAVIS

INSPECTOR G. SMART

WELL CONSTRUCTION		DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
			NO.	TYPE	BLOWS PER 6 INCHES		
CONCRETE CAP		0	S-1	SS	1-1-1-1	-----TOPSOIL-----	HNU - BACKGROUND
BENTONITE AND SAND GROUT		5				OUTWASH DEPOSITS	DAMP
		10	S-2	SS	4-5-8-9	TAN FINE TO MEDIUM GRAVEL, and fine to coarse sand	
BENTONITE AND SAND GROUT		15				TAN MEDIUM TO COARSE SAND, some medium to coarse gravel	DAMP
		20	S-3	SS	4-6-8-10		
BENTONITE		25				SAME	DAMP, STRATIFIED HNU BACKGROUND
		30	S-4	SS	4-5-8-11		
PURE BENTONITE		35				SAME	DAMP, STRATIFIED HNU BACKGROUND
		40	S-5	SS	4-7-9-12		
NATIVE SAND BACKFILL		45				D1-25	GROUNDWATER 46'



GROUNDWATER 46'



SHEET NO. 2 OF 2

JOB NO. 0628-05-28

D1-26



TEST BORING LOG
BORING NO. RFW-10

PROJECT : IRP - OTIS ANGB PHASE II - MODIFICATION

SHEET NO. 1 OF 2

CLIENT : USAF

JOB NO. 0628-05-28

BORING CONTRACTOR : D.L. MAHER

ELEVATION

GROUND WATER:

DATE	TIME	WATER EL.	SCREEN	CAS.	SAMP.	CORE	TUBE
				TYPE	SS		
				DIA.	2"		
				WT.	140		
				FALL	30"		

DATE STARTED 10/11/84

DATE FINISHED 10/12/84

DRILLER W. DAVIS

INSPECTOR G. SMART

WELL CONSTRUCTION		DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
			NO.	TYPE	BLOWS PER 6 INCHES		
	CONCRETE CAP	0	S-1/2	SS	1-1-1-1	TOP SOIL	
		5				OUTWASH DEPOSITS	
		10	S-3	SS	4-7-11-12	LIGHT BROWN FINE TO COARSE SAND, some fine to medium gravel	DAMP H ₂ O BACKGROUND
		15					
		20	S-4	SS	3-6-6-9	SAME - MORE FINE SAND	MOIST
		25					
		30	S-5	SS	4-8-9-11	LIGHT BROWN MEDIUM TO COARSE SAND, some fine to medium gravel	MOIST
		35					
		40	S-6	SS	6-6-9-14	SAME - MORE COARSE SAND	H ₂ O - BACKGROUND
		45					

SCHEDULE 80 2" ID PVC RISER
BENTONITE AND SAND GROUT

PURE
BENTONITE
SAND



TEST BORING LOG

BORING NO. RFW 10

PROJECT: IRP- OTS ANGB PHASE II - MODIFICATION

SHEET NO. 2 OF 2

CLIENT: U.S.A.F

JOB NO. 0628-OS-28

WELL CONSTRUCTION	DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
SCREEN 1/2" O.D. NATIVE SAND BACKFILL	45					
	50	S-7	SS	4-5-7- 12	YELLOWISH BROWN - SAME - 2" OXIDIZED LAYER AT 49'4" MORE FINES	GROUNDWATER 52'
	55					
	60	S-8	SS	3-4-5- 7	GRAYISH BROWN - SAME -	ORGANIC ODOR SATURATED. SNAKEN WATER SAMPLE GAVE H ₂ S READING OF 12 PPM ABOVE BACKGROUND.
	65					
	70	S-9	SS	3-5-6- 7	SAME - COLOR CHANGED FROM GRAYISH BROWN TO LIGHT BROWN IN BOTTOM 5" BOTTOM COARSER	H ₂ S READING OF SOIL 1-2 PPM ABOVE BACKGROUND
	75				BOTTOM OF HOLE	
	80					
	85					
	90					
	95					

PROJECT: IRP - OTIS ANGEL PHASE II - MODIFICATION

SHEET NO. 1 OF 2

CLIENT: USAF

JOB NO. 0622-05-28

BORING CONTRACTOR: D.L. MAHER

ELEVATION

GROUND WATER:

DATE	TIME	WATER EL.	SCREEN	CAS.	SAMP.	CORE	TUBE
					SS		
					2"		
					140		
					30"		

DATE STARTED 10/12/84

DATE FINISHED 10/16/84

DRILLER W. DAVIS

INSPECTOR G. SMART

WELL CONSTRUCTION		DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
			NO.	TYPE	BLOWS PER 6 INCHES		
CONCRETE CAP		0	S-1	SS	1-1-1-1	TOPSOIL	
						OUTWASH DEPOSITS	
BENTONITE AND SAND GROUT		5					
		10	S-2	SS	3-5-6-6	LIGHT BROWN MEDIUM TO COARSE SAND AND FINE TO MEDIUM GRAVEL	HNu - BACKGROUND MOIST
		15					
		20	S-3	SS	3-3-4-7	SAME - 2" OXIDIZED LAYER AT 19' 5"	HNu - SLIGHT NEEDLE DEFLECTION
		25					
		30	S-4	SS	4-4-5-7	SAME - 2" COARSE DAMP LAYER AT 29' 5"	HNu - 1 PPM ABOVE BACKGROUND
		35					
		40	S-5	SS	4-5-6-7	SAME - 2" OXIDIZED LAYER AT 39' 4"	
		45					
		48					
NATIVE SAND BACKFILL							

GROUNDWATER 45.3



TEST BORING LOG

BORING NO. RFW 11

PROJECT: IRP- OTS ANGB PHASE II - MODIFICATION

SHEET NO. 2 OF 2

CLIENT: U.S.A.F.

JOB NO. 0628-05-28

WELL CONSTRUCTION	DEPTH FEET	SAMPLE			CLASSIFICATION	REMARKS
		NO.	TYPE	BLOWS PER 6 INCHES		
SCREEN 10.10" NATIVE SAND BACKFILL	45					
	50	S-6	SS	2-3-5-6	SAME	SATURATED
	55					
	60	S-7	SS	2-3-5-7	SAME - COARSER LAST 3"	
	65				BOTTOM OF HOLE	
	70					
	75					
	80					
	85					
	90					
	95					

APPENDIX D-2

TEST PIT LOGS

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - Base Landfill - OTIS

SHEET OF

CLIENT: USAF-DEHL/ANG

CONTRACTOR: Richard Ruzick, B&W Contr. EQUIPMENT: INFL 200 BACKHOE

DEPTH TO WATER: INSPECTOR: R. L. KRAYBILL

LOG OF TEST PIT No. - 2

Date: 11/30/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		Brown m. SAND & GRAVEL BACKFILL/COVER 2.7	Dry
5		Burn fill w/ bottles metal debris RUSTED	
		Sharp boundary 8.0	
10		White-LIGHT TAN medium SAND 10.0	Moist-Dry
		END OF PIT	
15			
20			

COMMENTS:

D2-2

FIGURE

PROJECT No. CUZEC 528

TEST PIT LOGS

PROJECT: Phase II - BASE LANDFILL - OTISSHEET OF CLIENT: USAF - CEHL/ANGCONTRACTOR: Richard Bunick, B & W Corp. EQUIPMENT: INTL 260 BACKHOEDEPTH TO WATER: INSPECTOR: R. L. KraybillLOG OF TEST PIT No. 3Date: 11/30/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		TOPSOIL - Brown organic matter & SAND	
		0.5'	
		Brown medium SAND, some coarse-fine Gravel, frequent cobbles	Dry
5		5.0	
		WHITE-TAN MEDIUM SAND occasional cobbles	MOIST
		6.5	
		END OF PIT	NO REFUSE ENCOUNTERED
10			
15			
20			

COMMENTS:

D2-3

FIGURE

PROJECT: phase II- BASE LANDFILL -CT'S

SHEET OF

CLIENT: USAF-OEHL/ANG

CONTRACTOR: Richard Bunzick, B & W Contr EQUIPMENT: INTL 260 BACKHOE

DEPTH TO WATER: _____ INSPECTOR: R. L. Kraybill

LOG OF TEST PIT No.-5

Date: 11/30/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		Yellow brown medium Sand & GRAVEL w/ frequent cobbles CLEAN BACKFILL / COVER 2.0 ±	Dry
5		Refuse - UNBURNED Rusted 5 gallon drums WIRE - General Refuse	1 GALLON RUSTY Cannister - NO OBVIOUS LID - FULL
		Clean white-tan medium Sand	MOIST
		END OF PIT	
10			
15			
20			

COMMENTS:

D2-5

FIGURE



PROJECT No. 66280528

TEST PIT LOGS

PROJECT: Phase II - Base Landfill - OTIS

SHEET OF

CLIENT: USAF - CEHL/ANG

CONTRACTOR: Richard Benick, B & W Contr. EQUIPMENT: TMTL 260 BACKHOE

DEPTH TO WATER: INSPECTOR: R. L. KRAYBILL

LOG OF TEST PIT No. - 6

Date: 11/30/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		LIGHT BROWN MEDIUM SAND & GRAVEL grading to: Dark brown medium SAND & GRAVEL frequent cobbles	MOIST Clay Backfill
		Brown medium SAND	
5		Refuse, rusted - 5 gallon can Debris	Refuse fill
		P.T. Collapsing to 7.0'	
10		3' x 30' Area ADJACENT to Test Pit 6 CINDERS, RAGS 3 - 40 gal. paint drums Yellow paint residues on ground; 5 gal can (empty) Naptha Aliphatic Drum lid RINGS - Numerous	
15			
20			

COMMENTS:

D2-6

FIGURE

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - CFTA - OTIS

SHEET OF

CLIENT: USAF - CEHL/ANG

CONTRACTOR: Richard Benzies - BEW Contr.

EQUIPMENT: ITH 260 Backhoe

DEPTH TO WATER:

INSPECTOR: ZL Krauss

LOG OF TEST PIT No. 10

Date: 11/30/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
	10-1	BLACK coarse-fine SAND, some medium- fine Gravel grading to 0.2'	CONTAINED AREA DAMP - WET
	10-2	YELLOW coarse-medium SAND some medium-fine Gravel 0.5' Gray SILT & very fine SAND w/ little oxidized fine gravel 1.5'	HNO ₃ < 1ppm CORROSION HYDROCARBON DAMP MIN 1"
5	10-3	YELLOW medium SAND occasional cobbles & interbeds of tan fine- medium Sand	NO ODOR HNO ₃ - Background below 2'± MUST - DAMP
10		END OF PIT 8.5'	
15			
20			

COMMENTS:

D2-10

FIGURE



PROJECT No. 062E052E

TEST PIT LOGS

PROJECT: Phase II - CFTB - CTIS

SHEET OF

CLIENT: USAF - CEHL/ANG

CONTRACTOR: Richard Bunzick B&V Contr EQUIPMENT: I-11 200 Pail-Lee

DEPTH TO WATER:

INSPECTOR: R. C. Kraybill

LOG OF TEST PIT No. 11

Date: 11/30/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
	1-1	Black medium SAND, some medium-fine Gravel occasional cobbles; becoming	OIL STAINED AMP DAMP H-Nu > 20 Hy. Incubation Odor Firm - Damp
	11-2	Gray clayey SILT w/ Embedded fine Gravel	
5			H-Nu 15 > 20
		Yellow-brown medium SAND, little medium- fine Gravel, occasional- frequent cobbles	Loose & Firm - Damp
	11-3		H-Nu 5-7
10		END OF PIT	H-Nu 3-5
15			
20			

COMMENTS:

D2-11

FIGURE

PROJECT: Phase II - CFTA - OTIS

SHEET OF

CLIENT: USAF - OEH/ANG

CONTRACTOR: Edward Bunick - B&W Contr. EQUIPMENT: Int'l 200 Backhoe

DEPTH TO WATER: INSPECTOR: R L Krambill

LOG OF TEST PIT No. 12

Date: 11/30/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		Brown SAND & Gravel	Hydrocarbon Color
		1.3'	
		Gray fine SAND & SILT	
		of inclusions of red coarse -	
		medium SAND, some coarse -	
	12-1	fine Gravel, occasional	
		Cobbles becoming	
		4.0'	
5		Gray to deep reddish brown	HNU-10-20
		coarse - medium SAND, some	100% - med. coarse
		medium - fine Gravel, occasional	100%
		to frequent Cobbles	
	12-2	(lenses of Gray & Red SAND)	
10		END OF PIT	HNU-10
15			
20			

COMMENTS:

D2-12

FIGURE

FIGURE

PROJECT: Phase II - CRTL - CT'S

SHEET OF

CLIENT: USAF - CENL/ANG

CONTRACTOR: General Electric - P&W - Contr.

EQUIPMENT: Cat 260 Backhoe

DEPTH TO WATER:

INSPECTOR: RL Krampall

LOG OF TEST PIT No. 15

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE NO. DEPTH	CLASSIFICATION	TEST RESULTS
		<u>BROWN TOPSOIL</u> 0.25'	
		Deep reddish brown coarse-medium SAND & coarse-fine GRAVEL	HN as background (6)
			moist
		1.25'	
		yellow brown coarse-medium SAND, some + medium-fine Gravel, occasional clayey SILT inclusions	
5			moist - damp
	15-1		
		<u>breccia</u>	
		Thin coarse-medium SAND & coarse-fine Gravel	LC color
			thin - fine & medium
			very damp
10			
		8.5'	
		END OF PIT	
15			
20			

COMMENTS:

D2-15

FIGURE

PROJECT: Phase II - CFTX-OTIS

SHEET OF

CLIENT: USAF - CEHL/ANG

CONTRACTOR: Richards Surface Eng. Contr. EQUIPMENT: 200 3.000

DEPTH TO WATER: INSPECTOR: R. L. Kneibell

LOG OF TEST PIT No. 16

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		DARK BROWN TOPSOIL	
		Brown loam - fine SAND	0.25'
	16-1	Silt + Coarse fine Gravel	1.0'
		Gray brown fine SAND & Clayey SILT	2.0
5	16-2	TAN coarse-medium SAND & coarse-medium GRAVEL	- HNU-3-5 SLIGHTLY CLAY THROUGHOUT profile
		Cobble layer at 4.5'	
		END OF PIT	6.0 - HNU-4
10			
15			
20			

COMMENTS:

D2-16

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - CFTA-CTIS

SHEET OF

CLIENT: LSAF - CEHL/ANG

CONTRACTOR: Richard Burtick, BSW/CAV.

EQUIPMENT: LTL 260 HAT-100

DEPTH TO WATER:

INSPECTOR: RL KAYRILL

LOG OF TEST PIT No. 17

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		TOPSOIL	
		Brown fine SAND & SILT embedded Gravel	0.25'
	17-1	Tan coarse-fine SAND & coarse-fine GRAVEL occasional-frequent Cobbles	1.5'
5			MOIST
		END OF PIT	4.0
10			H.Nu 3-5 but no silty clay
15			
20			

COMMENTS:

D2-17

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - NDI - OTIS

SHEET OF

CLIENT: USAF - DEHL/ANG

CONTRACTOR: Richard Bunick B&W Contr. EQUIPMENT: INTL 260

DEPTH TO WATER: INSPECTOR: PL. KRAYBILL

LOG OF TEST PIT No. 19

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		Granular Fill SAND & MACadam Numerous Cobbles	TEST PIT IN AREA of STORM. WATER RUNOFF WET
5	19-1	END OF PIT	↓ extent of fill NOT determined
10			
15			
20			

COMMENTS:

D2-19

FIGURE





PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - NDI - OTIS

SHEET OF

CLIENT: USAF - OEH/ANG

CONTRACTOR: Richard Bunzick, IS&W Contr. EQUIPMENT: INT'L 260 BACKHOE

DEPTH TO WATER: INSPECTOR: R.L. KRAYBILL

LOG OF TEST PIT No. 21

Date:

Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
	21-11	TOPSOIL/GRASS	
		Brown-Black coarse-medium SAND & coarse-fine Gravel	WET, LOOSE
			HNO ₃ - Background (0)
5			Sample from Swake down gradient from NDI
10			
15			
20			

COMMENTS:

D2-21

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: PHASE II - FFTH - CTIS

SHEET OF

CLIENT: USAF - OEH/ANG

CONTRACTOR: RICHARD BENZICK, B&N Contr.

EQUIPMENT: Intl 200 Pressure

DEPTH TO WATER:

INSPECTOR: R.L. Kaulhill

LOG OF TEST PIT No. 23

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
	NC SAMPLES	SOLID MACADAM	Appears as a liquid MACADAM: DUMP SITE - impermeable H ₂ O = 0
		END OF PIT 2.0'	
5			
10			
15			
20			

COMMENTS:

D2-23

FIGURE

FIGURE

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - EFTA-OTIS

SHEET OF

CLIENT: USAF - OENL/ANG

CONTRACTOR: RICHARD KUNZICK, 157W CONTR. EQUIPMENT: INTL 260 BACKHOE

DEPTH TO WATER:

INSPECTOR:

LOG OF TEST PIT No. 28

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		Granular fill & refuse to 11' Burn fill, CINDERS	NO GATORS
5			HN-2-3 (BACKGROUND)
10		TAN MEDIUM SAND @ 11.0' 11'	
	28-1	CLEAN	
		END OF PIT 12.0'	
15			
20			

COMMENTS:

D2-28

FIGURE

PROJECT: Phase II - FFTA-CTIS

SHEET OF

CLIENT: CSAF-CEHL/ANG

CONTRACTOR: RICHARD BONZICK & SONS EQUIPMENT: TAIL 260 PICKUP

DEPTH TO WATER:

INSPECTOR: R. L. KR2413/LC

LOG OF TEST PIT No. 29

Date: 12/1/83 Elevation:

[illegible]

COMMENTS:

D2-29

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - FETH - OTIS

SHEET OF

CLIENT: USAF - DEHLIANG

CONTRACTOR: RICHARD BLINZICK, B&W Contr. EQUIPMENT: INTL 200 B.C. 1000

DEPTH TO WATER:

INSPECTOR: R. L. Kraybill

LOG OF TEST PIT No. 30

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE NO. DEPTH	CLASSIFICATION	TEST RESULTS
		Tan medium SAND little coarse-fine Gravel occasional cobbles	HNL - Background (S)
	NO SAMPLES		
5		END OF PIT	4.5'
10			
15			
20			

COMMENTS:

D2-30

FIGURE

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: Phase II - EFTA - OTIS

SHEET OF

CLIENT: USAF - CEHL/ANG

CONTRACTOR: RICHARD BENZICK, R & W Contr.

EQUIPMENT: JTL 260 BACKHOE

DEPTH TO WATER:

INSPECTOR: R.L. KRAYBILL

LOG OF TEST PIT No. 32

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		RP SOIL w/ concrete grading to	FILL
	NO SAMPLES	DARK BROWN SAND MACADAM	MOIST - DAMP
5			HA - 3 (BACKGROUND)
		END OF PIT 6.0'	
10			
15			
20			

COMMENTS:

D2-32

FIGURE



PROJECT No. 06280528

TEST PIT LOGS

PROJECT: GRASP TL - FETA - OTIS

SHEET OF

CLIENT: USAF - CEHLING

CONTRACTOR: RICHARD RUNZICK, ISAW Contr. EQUIPMENT: TATL L&C SICKLER

DEPTH TO WATER:

INSPECTOR: P. L. KRAYBILL

LOG OF TEST PIT No. 33

Date: 12/1/83 Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		Burn fill & Black SAND & Gravel Frequent cobbles	In Suale finu - BAKER (3) moist-wet
5	33-1	5.5'	
10			
15			
20			

COMMENTS:

D2-33

FIGURE

FIGURE

FIGURE



PROJECT No. 0629-05-28

TEST PIT LOGS

PROJECT: IRP STUDY OTIS ANGB - PHASE II MODIFICATION

SHEET 1 OF 1

CLIENT: U.S. AIR FORCE

CONTRACTOR: ROBER-CHILDS INC

EQUIPMENT: CASE MODEL S80 BACKHOE

DEPTH TO WATER:

INSPECTOR: G SMART

LOG OF TEST PIT No. TP-3A (SITE 4)

Date: 10/2/94

Elevation: 106.21

DEPTH FT.	SAMPLE NO. DEPTH	CLASSIFICATION	TEST RESULTS
		DISCOLORED LAYER AT 8'	BACKHOE PIT - SHIP NO READING ABT CIRCULAR SAMPLE TAKEN FROM DISCOLORED LAYER
5		TAN COARSE GRAVEL AND SAND	
10			
15			
20			

COMMENTS:

D2-36

FIGURE

FIGURE

FIGURE

FIGURE

FIGURE

FIGURE

PROJECT: OTIS AIR NATIONAL GUARDIAN - PHASE II IIRI STUDY

SHEET 1 OF 1

CLIENT: US AIR FORCE

CONTRACTOR: ROBERT CHILD

EQUIPMENT: CASE BACKHOE

DEPTH TO WATER: NONE ENCOUNTERED

INSPECTOR: S. SMART

LOG OF TEST PIT No. TP 4B

Date: 10/2/84

Elevation:

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		TOP SOIL	BACKGROUND WITH 100 NO BENDING ABOVE BACKGROUND
		SUB SOIL	
		TAN MEDIUM SAND INTERBEDDED WITH TAN FINE SAND AND Silt	
		STRATIFIED MEDIUM TO COARSE SAND AND TAN GRAVEL and COARSE SAND	
5			
10			
15			
20			

COMMENTS:

D2-45

FIGURE

FIGURE

FIGURE



PROJECT No. 0623-05-28

TEST PIT LOGS

PROJECT: ERP STUDY OTIS ANGB - PHASE II MODIFICATION

SHEET 1 OF 1

CLIENT: U.S. AIR FORCE

CONTRACTOR: ROBERT CHILDS INC

EQUIPMENT: CASE MODEL S20 BACKHOE

DEPTH TO WATER:

INSPECTOR: S. SMART

LOG OF TEST PIT No. TP-6

Date: 10/1/84

Elevation: 108.49

DEPTH FT.	SAMPLE NO. DEPTH	CLASSIFICATION	TEST RESULTS
		TOP SOIL	
		SUB SOIL	
			NO READING 3' FROM
			NO READING 1' FROM
			2' FROM
		2'-12" BAND OF GRAY SILT, SOME FINE SAND dipping 30° from 3-4'	
5		TAN COARSE GRAVEL AND SAND	
10			
15			
20			

COMMENTS:

D2-51

FIGURE



PROJECT No. 0628-05-28

TEST PIT LOGS

PROJECT: IRP STUDY OTIS ANGB - PHASE II MODIFICATION

SHEET 1 OF 1

CLIENT: U.S. AIR FORCE

CONTRACTOR: ROBERT CHILDS INC.

EQUIPMENT: CASE MODEL 580 BACKHOE

DEPTH TO WATER:

INSPECTOR: S. SMART

LOG OF TEST PIT No. TP-7

Date: 12/1/94

Elevation: 108.46

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		TOP SOIL	1110 BACKHOE - 32-00
		SUBSOIL	NO READING - 11000
		OXIDIZED ZONE AND DISCONTINUOUS TRANSITION LAYER	10400 (GRUNN)
		TAN COARSE GRAVEL AND SAND	
5		DISCONTINUOUS LAYER OF GRAY SILT, SOME FINE SAND FROM 4-6'	
10			
15			
20			

COMMENTS:

D2-52

FIGURE

FIGURE



PROJECT No. 0628-05-28

TEST PIT LOGS

PROJECT: IRP STUDY CTIS ANGB - PHASE II MODIFICATION

SHEET 1 OF 1

CLIENT: U.S. AIR FORCE

CONTRACTOR: ROBERT CHILDS INC

EQUIPMENT: CASE MODEL S20 BACKHOE

DEPTH TO WATER:

INSPECTOR: S. SMART

LOG OF TEST PIT No. TP-11

Date: 10/1/84 Elevation: 109.21

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		TOPSOIL	BACKGROUND LINE - 51221
		SUBSOIL	NO READINGS ATIVE
		GRAY SILT, some fine sand with pebbles	BACKGROUND
		TAN COARSE GRAVEL some sand	
5		TAN/BROWN GRAVEL AND COARSE SAND	
10			
15			
20			

COMMENTS:

D2-56

FIGURE

FIGURE



PROJECT No. 0628-05-28

TEST PIT LOGS

PROJECT: IRP STUDY OTIS ANGB - PHASE II MODIFICATION

SHEET 1 OF 1

CLIENT: U.S. AIR FORCE

CONTRACTOR: ROBERT CHILDS INC

EQUIPMENT: CASE MODEL 520 BACKHOE

DEPTH TO WATER:

INSPECTOR: S. SMART

LOG OF TEST PIT No. 72-16

Date: 10/1/88

Elevation: 100.37

DEPTH FT.	SAMPLE No. DEPTH	CLASSIFICATION	TEST RESULTS
		TOPSOIL	
		SUBSOIL	
		1/2" LAYER OF DISCOLORED SOIL	BACK-SOUND HARD - 3" DIA
		OXIDIZED COARSE GRAVEL AND SAND	NO RESPONSE - 2"
			2.5" DIA
			LATE SILT - USE TR 2-511
		GRAY SILT, SOME FINE SAND WITH PEBBLES	FROM 6" - 1"
5			
		BROWN COARSE GRAVEL AND SAND	
10			
15			
20			

COMMENTS:

D2-61

FIGURE

FIGURE

FIGURE

APPENDIX D-3

OTHER AREA WELL LOGS

American Drilling & Boring Co., Inc.

-52-

SHEET 1 OF 2

100 WATER STREET EAST PROVIDENCE, R I

TO Woods Hole Oceanographic Institute ADDRESS Woods Hole, Mass.
PROJECT NAME Test Boring - Otis Air Force LOCATION Falmouth, Mass.
REPORT SENT TO above Base PROJ. NO. 4-174
SAMPLES SENT TO " OUR JOB NO. 4-174

DATE 10/24/73
MOLE NO. 1
LINE & STA.
OFFSET
SURF. ELEV.

GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE BAR	Date	Time
At <u> </u>	after <u> </u> Hours	Type <u>4" Mud Hole</u>				START <u>10/24/73</u>	<u> </u> a.m.
At <u> </u>	after <u> </u> Hours	Size I.D. <u> </u>				COMPLETE <u>11/1/73</u>	<u> </u> p.m.
		Hammer Wt. <u> </u>			BIT	TOTAL HRS. <u> </u>	
		Hammer Fall <u> </u>				BORING FOREMAN <u>C. Leiting</u>	
						INSPECTOR <u> </u>	
						SOILS ENGR. <u> </u>	

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc	SAMPLE		
				From	To					No	Pen	Rec
				0-6	6-12	12-18			No Samples required from 0' to 10'			
		10'-11'6"	D	6	9	13	Wet medium dense		Brown fine to coarse SAND, trace of silt, Cobbles	1	18" 10"	
		15'-16'6"	D	5	11	10	"			2	18" 11"	
		20'-21'6"	D	20	21	25	Wet dense			3	18" 8"	
		25'-26'6"	D	18	13	22	Wet dense	25'	Brown fine to coarse SAND, little fine to coarse gravel, trace of silt	4	18" 9"	
		30'-31'6"	D	16	9	47	Wet very dense		(From 30' to 35' - Pushed Cobble)	-	15" 9"	
		35'-35'5"	D	10	13	17	Wet dense	40'		5	16" 9"	

GROUND SURFACE TO

USED "CASING THEN

Sample Type
C: Dry C-Cored W: Washed
UP: Undisturbed Piston
TP: Test Pit & Auger V: Vane Test
DT: Disturbed Thruwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt & 30" fall on 2" O.D. Sampler
Consistency Density
0-10 Loose
10-30 Med Dense
30-50 Dense
50+ Very Dense
Cohesive Consistency
0-4 Soft 30+ Hard
4-8 M/Soft
8-15 S-H
15-30 V-Still

Earth Boring 250'
Rock Boring
Sampling

HOLE NO. 1

1974 PRESS - EAST PROV.

American Drilling & Boring Co., Inc.

100 WATER STREET

LAST PROVIDENCE, R I

-53-

SHEET 2 OF 7

DATE _____

MOLE NO 1

LINE & STA _____

OFFSET _____

SURF ELEV _____

TO _____ ADDRESS _____
PROJECT NAME _____ LOCATION _____
REPORT SENT TO _____ PROJ NO _____
SAMPLES SENT TO _____ OUR JOB NO 4-176

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR	Date	Time
At _____	after _____ Hours	Type _____	_____	_____	START _____	a.m.
At _____	after _____ Hours	Size I.D. _____	_____	_____	COMPLETE _____	p.m.
		Hammer Wt _____	_____	BIT _____	TOTAL HRS. _____	a.m.
		Hammer Fall _____	_____	_____	BORING FOREMAN _____	
					INSPECTOR _____	
					SOILS ENGR. _____	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Roca-color, type, condition, hardness, Drilling time, seams and etc	SAMPLE		
				From 0-6	6-12	12-18				No	Pen	Rec
		40'-41'6"	D	7	9	14	Wet medium dense		Brown fine to coarse SAND, trace of fine gravel, trace of silt	6	18"	12"
		45'-46'5"	D	15	23	28	Wet very dense			7	18"	6"
		50'-51'6"	D	10	14	19	Wet dense			8	18"	15"
		55'-56'6"	D	13	18	22	"			9	18"	9"
		60'-61'6"	D	8	16	20	Wet dense	60'	Brown coarse to fine SAND & medium to fine Gravel, little silt, trace of clay	10	18"	7"
		65'-66'6"	D	9	9	8	Wet medium dense	65'	Brown fine to coarse SAND, trace of fine gravel, trace of silt	11	18"	5"
		70'-71'6"	D	31	14	12	Wet medium dense	70'	Brown fine to coarse SAND, trace of coarse gravel, trace of silt	12	18"	11"
		75'-76'6"	D	8	9	10	Wet medium dense	75'	Brown fine to coarse SAND, trace of silt	13	19"	3"
								80'				

GROUND SURFACE TO _____

USED

"CASING. THEN

Sample Type
D: Dry C: Cored W: Washed
UP: Undisturbed Piston
TP: Test Pit A: Auger V: Vane Test
UT: Undisturbed Thruwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

MOB Wt = 30" fall on 2" O.D. Sampler
Cohesiveness Density
0-10 Loose
10-30 Med. Dense
30-50 Dense
50+ Very Dense

Cohesive Consistency
0-4 Soft 30+ Hard
4-8 M/Shift
8-13 Stiff
15-30 V-Shift

SUMMARY
Earm Using _____
Roca Coring _____
Samples _____

HOLE NO 1

1000 PRESS - EAST PROV.

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I

-54-

SHEET 3 OF 7

DATE _____

HOLE NO 1

LINE & STA. _____

OFFSET _____

SURF. ELEV. _____

TO _____ ADDRESS _____

PROJECT NAME _____ LOCATION _____

REPORT SENT TO _____ PROJ NO _____

SAMPLES SENT TO _____ OUR JOB NO. 4-174

GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE BAR	Date	Time
At _____	after _____	Hours	Type _____	_____	_____	START _____	a.m.
At _____	after _____	Hours	Size I.D. _____	_____	_____	COMPLETE _____	p.m.
			Hammer Wt _____	_____	BIT _____	TOTAL HRS. _____	a.m.
			Hammer Fall _____	_____	_____	BORING FOREMAN _____	
						INSPECTOR _____	
						SOILS ENGR. _____	

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Roca-color, type, condition, hardness, Drilling time, seams and etc	SAMPLE		
				From 0-6	To 6-12	To 12-18				No	Pen	Rec
		80'-81'6"	D	10	13	13	Wet medium dense		Brown fine to coarse SAND, trace of fine gravel, trace of silt (From 83' to 90' - One mass of Cobbles ranging from 6" to 1')	14	18"	15"
								90'				
		90'-91'6"	D	12	15	16	Wet dense		Brown fine to coarse SAND, trace of fine to medium gravel, trace of silt, Cobbles	15	18"	13"
		95'-96'6"	D	11	16	20	"			16	18"	17"
		100'-101'6"	D	9	13	10	Wet medium dense			17	18"	11"
		105'-106'6"	D	19	15	18	Wet dense			18	18"	10"
		110'-111'6"	D	13	14	29	"			19	18"	13"
		115'-116'6"	D	7	21	16	"			20	18"	12"

GROUND SURFACE TO	USED	CASING	THEN	SUMMARY
Sample Type	Proportions Used	140lb Wt & 30' fall on 2" O.D. Sampler	Cohesiveness Density	Cohesive Consistency
D: Dry C: Cored W: Washed	trace 0 to 10%	0-10 Loose	0-4 Soft	30+ Hard
UP: Undisturbed Piston	little 10 to 20%	10-30 Med Dense	4-8 M/Shift	
TP: Test Pit A: Auger V: Vane Test	some 20 to 35%	30-50 Dense	8-15 Stiff	
UT: Undisturbed Thruwall	and 35 to 50%	50+ Very Dense	15-30 V-Shift	
<p>FORM 1055 - EAST PROV</p>				<p>HOLE NO <u>1</u></p>

SHEET 4 OF 7

100 WATER STREET EAST PROVIDENCE, R. I.

DATE _____

TO _____ ADDRESS _____
PROJECT NAME _____ LOCATION _____
REPORT SENT TO _____ PROJ. NO _____
SAMPLES SENT TO _____ OUR JOB NO 4-174

DATE 1

FILE NO. _____

LINE & STA. _____

OFFSET _____

DATE:

SURF. ELEV. _____

GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE BAR	Date	Time
At _____	after _____	Hours	Type _____	_____	_____	START _____	_____
			Size I.D. _____	_____	_____	COMPLETE _____	_____
			Hammer Wt _____	_____	_____	TOTAL MRS. _____	_____
At _____	after _____	Hours	Hammer Fall _____	_____	BIT _____	BORING FOREMAN _____	_____
				_____	_____	INSPECTOR _____	_____
				_____	_____	SOILS ENGR. _____	_____

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sampler	Blows per 6" on Sampler			Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Roca-color, type, condition, hard- ness, Drilling time, seams and etc	SAMPLE		
				From 0-6"	To 6-12"	To 12-18"				No	Pen	Rec.
		120'-121'6"	D	14	10	22	Moist dense		Brown fine to coarse SAND, trace of fine to medium gravel, trace of silt, Cobbles	21	18"	16"
		125'-126'6"	D	6	9	35	Wet dense			22	18"	11"
		130'-131'6"	D	28	30	34	Moist very dense			23	19"	24"
		135'-136'6"	D	10	10	10	Wet medium dense			24	18"	10"
		140'-141'6"	D	9	13	16	"			25	18"	24"
		145'-146'6"	D	15	11	12	"			26	18"	17"
		150'-151'6"	D	10	15	21	Wet dense	150'	Brown fine to coarse SAND, some fine to medium gravel, trace of silt	27	18"	9"
		155'-156'6"	D	12	26	17	"			28	17"	12"

GROUND SURFACE TO _____

USED _____ "CASING: THEN

Sample Type
C: Dry C: Core W: washed

UP: Undisturbed Piston
TP: Test Piston As Auger Vs Vane Test
UT: Undisturbed Thinwall

1974 2811 - 1011 2807.

Proportions Used

none	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%.

140 lb Wt. 30" tall on 2" g.d. Scales

Cohesiveness Density		Cohesure Consistency	
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M/Shift
30-50	Dense	8-15	Shift
50 +	Very Dense	15-30	V-Shift

SUMMARY

Earth Boring _____
Rock Coring _____
Samples _____

HOLE NO 1

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R. I.

-56-

SHEET 5 OF 7

DATE _____

HOLE NO 1

LINE & STA _____

OFFSET _____

SURF. ELEV. _____

TO _____ ADDRESS _____
PROJECT NAME _____ LOCATION _____
REPORT SENT TO _____ PROJ. NO _____
SAMPLES SENT TO _____ OUR JOB NO 4-174

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR	Date	Time
At _____	after _____ Hours	Type _____	_____	_____	START _____	am
At _____	after _____ Hours	Size I D _____	_____	_____	COMPLETE _____	pm
		Hammer Wt _____	_____	BIT _____	TOTAL HRS. _____	
		Hammer Fall _____	_____	_____	BORING FOREMAN _____	
					INSPECTOR _____	
					SOILS ENGR. _____	

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc	SAMPLE		
				From 0-6"	6-12"	To 12-18"				No	Pen	Ret
		160'-161'6"	D	37	52	68	Wet very dense		Pushing Cobble	-	18"	0"
									Brown fine to coarse SAND, some fine to medium gravel, trace of silt			
		165'-166'6"	D	19	19	16	Wet dense			29	18"	8"
		170'-171'6"	D	23	23	25	"			30	18"	13"
		175'-176'6"	D	61	84	97	Wet very dense		Cobble	-	18"	0"
								180'				
		180'-181'6"	D	30	36	28	Wet very dense		Brown fine to medium SAND, some silt, little fine to medium gravel	31	18"	18"
									(From 185' to 189' - Cored Cobbles)			
								189'				
		189'-190'6"	D	11	15	17	Wet dense		Brown fine to coarse SAND, trace of silt	32	18"	15"
		196'-197'6"	D	13	21	20	"			33	18"	12"

GROUND SURFACE TO	USED	"CASING. THEN	SUMMARY
Sample Type	Proportions Used	140lb Wt. a 30" fall on 2" O.D. Sampler	
D: Dry C: Cored W: washed	trace 0 to 10%	Cohesiveness Density	Earth (urn) _____
UP: Undisturbed Piston	fine 10 to 20%	Cohesive Consistency	Moist Casing _____
TP: Test Pit A: Auger V: Vane Test	some 20 to 35%	0-10 Loose	Samples _____
UT: Undisturbed Thinwall	and 35 to 50%	10-30 Med Dense	
		30-50 Dense	
		50+ Very Dense	
		0-4 Soft 30+ Hard	
		4-8 M/Shift	
		8-15 Stiff	
		15-30 V-Stiff	

1000 PRESS - EAST PROV.

HOLE NO 5

American Drilling & Boring Co., Inc.

100 WATER STREET EAST PROVIDENCE, R I

-57-

SHEET 6 OF 7

DATE

HOLE NO. 1

LINE & STA

OFFSET

SUFF. ELEV.

TO _____ ADDRESS _____
PROJECT NAME _____ LOCATION _____
PORT SENT TO _____ PROJ NO. _____
SAMPLES SENT TO _____ OUR JOB NO. 4-174

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR	Date	Time
At _____	after _____ Hours	Type _____	_____	_____	START _____	_____
At _____	after _____ Hours	Size I.D. _____	_____	_____	COMPLETE _____	_____
		Hammer Wt. _____	_____	BIT	TOTAL HRS. _____	_____
		Hammer Fall _____	_____	_____	BORING FOREMAN _____	_____
					INSPECTOR _____	_____
					SOILS ENGR. _____	_____

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist	Strata Change Elev	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Also color, type, condition, hardness, Drilling time, seams and etc	SAMPLE		
				From 0-6	6-12	To 12-18				No	Pen	Rec
		201'-202'6"	D	19	22	25	Wet dense		Brown fine to coarse SAND, trace of silt	34	18"	13"
								206'				
		206'-207'6"	D	13	18	20	Wet dense		Brown fine SAND, little silt	35	18"	12"
								212'				
		212'-213'6"	D	15	15	23	Wet dense		Brown fine SAND, some silt	36	18"	9"
		217'-218'6"	D	24	16	20	Moist dense			37	18"	10"
								222'				
		222'-223'6"	D	13	18	24	Wet dense		Brown fine SAND, little silt	38	18"	14"
		227'-228'6"	D	10	11	16	Wet medium dense			39	18"	12"
		232'-233'6"	D	14	17	20	Wet dense			40	18"	15"
		237'-238'6"	D	15	12	15	Wet medium dense			41	18"	16"

GROUND SURFACE TO	USED	CASING	THEN	SUMMARY
Sample Type	Proportions Used	140 lb Wt. 30" fall on 2" O.D. Sampler	Cohesionless Density	Cohesive Consistency
D: Dry C: Cored W: Washed	trace 0 to 10%	0-10 Loose	0-4 Soft	30+ Hard
UP: Undisturbed Piston	fine 10 to 20%	10-30 Med Dense	4-8 M/Shift	
TP: Test Pit A: Auger V: Vane Test	same 20 to 35%	30-50 Dense	8-15 Stiff	
UF: Undisturbed Thruwall	and 35 to 50%	50+ Very Dense	15-30 V-Stiff	
TOWN PRESS - EAST PROV.				HOLE NO 1

APPENDIX E

SITE SAFETY PLAN



WORK LOCATION PERSONNEL PROTECTION
AND SAFETY EVALUATION FORM

Attach Pertinent Documents/Data

Fill in Blanks As Appropriate

WO # 0628-05-28

Division 1530

Office CONCORD

Prepared by GLENN SMART

Date _____

Reviewed by PLK

Date SEP 1, 1984

Approved by _____

Date _____

A. Work Location Description

1. Name OTTIS AIR NATIONAL GUARD BASE,
MA.

2. Location PORTSMOUTH
NH,

3. Type: HW Site ☒

Industrial ☒

Spill ☒

Construction ☐

☐ Existing WESTON Work Location

☐ Existing Client Work Location

Other ☒ Describe NATIONAL GUARD BASE WITH SEVERAL
SELECTED AREAS OF PAST WASTE DISPOSAL, AND SPILLS

4. Status ACTIVE

5. Anticipated activities: INSTALLATION AND SAMPLING OF
MONITORING WELLS, SAMPLING OF ABANDONED FUEL ^{LINE} HEADER PIPES

6. Size 3230 ACRES

7. Surrounding Population _____

8. Buildings/Homes/Industry BASE HOUSING, SUPPORT BUILDINGS, AND
MILITARY BASE FACILITIES.

9. Topography FLAT TO GENTLY SLOPING OUTWASH PLAIN AND STEEPSIDED KETTLE HOLES.
10. Anticipated Weather _____
11. Unusual Features MILITARY INSTALLATION
12. Site History MAJOR MILITARY TRAINING FACILITY DURING WORLD WAR II HOUSING UP TO 40,000 PEOPLE. CURRENTLY, AIR NATIONAL GUARD BASE.

B. Hazard Description

1. Background Review: Complete (X) Partial ()

If partial, why? _____

2. Hazard Level:

A ()	B ()
Unknown ()	C ()
	D (X)

Justification PREVIOUS ONSITE STUDY, PERSONNEL WORKING THROUGHOUT BASE

3. Types of Hazards:

- | | | |
|-----------------|------------------|-------------------------|
| A. Chemical () | Inhalation (X) | Explosive () |
| Biological () | Ingestion (X) | O ₂ Def. () |
| | Skin Contact () | Toxic (X) |

Describe FIRE DEPARTMENT TRAINING AREAS, LANDFILLED DOMESTIC AND INDUSTRIAL WASTES, POSSIBLE LEAKING FUEL TANKS

- | | | |
|-----------------|-----------------|-----------|
| B. Physical () | Cold Stress (X) | Noise (X) |
| | Heat Stress (X) | Other () |



Describe Possibility of Cold or Heat Stress externally.

Possibility of noise hazard if work is conducted in
close proximity to action aircraft

C. Radiation ()

Describe _____

4. Nature of Hazards:

Air () Describe _____

Soil (X) Describe POSSIBLE LANDFILLED INDUSTRIAL WASTES,
(SOLVENTS, WASTE OIL, WASTE PAINT PRODUCTS)

Surface Water () Describe _____

Groundwater (X) Describe POSSIBLY CONTAMINATED GROUNDWATER
FROM LEACHING INDUSTRIAL WASTES AND/OR SPILLED FUEL

Other () Describe _____

5. Chemical Contaminants of Concern

<u>Contaminant</u>	<u>TLV (PPM)</u>	<u>I.D.L.H. (PPM)</u>	<u>Source/Quantity Characteristics</u>	<u>Route of Exposure</u>	<u>Symptoms of Acute Exposure</u>	<u>Instruments Used to Monitor Contaminant</u>
BENZENE	10 PPM	2000 PPM		INHALATION DERMAL	IRRITATION OF EYES, NOSE; NAUSEA	HN ₄
TOLUENE	100 PPM	2000 PPM		INHALATION DERMAL	WEAKNESS, CONFUSION DERMATITIS	HN ₄
XYLENES	100 P	10,000 PPM		INHALATION DERMAL	DIZZINESS; IRRITATED EYES, NOSE, THROAT; NAUSEA, ABDOMINAL PAIN.	HN ₄
(4) TCE	50 PPM	1000 PPM		INHALATION	VERTIGO, NAUSEA, CARDIAC ARRHYTHMIA	HN ₄

6. Physical Hazards of Concern

<u>Hazard</u>	<u>Description</u>	<u>Location</u>	<u>Procedures Used to Monitor Hazard</u>
I LEAKY FUEL TANKS - AND LINES	MIGRATION OF SPILLED OR LEAKING FUEL THROUGH OVERBURDEN TO GROUNDWATER	A) PETROLEUM STORAGE AREA B.) RAILYARD FUEL PUMPING SITE	MONITOR WITH H/N ₄ P101 PHOTO IONIZATION DETECTOR
II IMPROPERLY HANDLED - FUEL	"	A.) AV GAS DUMP TEST SITE	"
III LANDFILLED WASTES - DOMESTIC AND INDUSTRIAL WASTES THROUGH OVERBURDEN TO GROUNDWATER	MIGRATION OF BURIED WASTES THROUGH OVERBURDEN TO GROUNDWATER	A.) LANDFILL	"
IV FIRE TRAINING AREAS	MIGRATION OF RESIDUE FROM FIRE TRAINING, INCLUDING, FUEL OIL, HEATING OIL, AND POSSIBLY SOLVENTS FROM SITE TO GROUNDWATER	A.) CURRENT FIRE FIGHTING TRAINING AREA B.) FORMER FIRE FIGHTING TRAINING AREA	"

7. Work Location Instrument Readings

Location _____

% O₂ _____

Radioactivity _____

FID _____

Other _____

% LEL _____

PID _____

Other _____

Other _____

Location _____

% O₂ _____

Radioactivity _____

FID _____

Other _____

% LEL _____

PID _____

Other _____

Other _____

Location _____

% O₂ _____

Radioactivity _____

FID _____

Other _____

% LEL _____

PID _____

Other _____

Other _____

Location _____

% O₂ _____

Radioactivity _____

FID _____

Other _____

% LEL _____

PID _____

Other _____

Other _____

8. Hazards expected in preparation for work assignment.

Describe: POSSIBLE RESPIRATORY HAZARDS FROM VOLATILE
ORGANIC COMPOUNDS ASSOCIATED WITH PETROLEUM PRODUCTS,
OR SOLVENTS



Personnel Protective Equipment

1. Level of Protection

A () B () C () D (X) Location/Activity:

WITH UPGRADE TO C IF LEVELS EXCEED 5 PPM ABOVE BACKGROUND ON H₂N₂

A () B () C () D () Location/Activity:

2. Protective Equipment (specify probable quantity required)

Respiratory

() SCBA, Airline

(X) Full Face Respirator
(Cart. GMC-H)

() Escape Mask

() None

() Other _____

() Other _____

Head & Eye

(X) Hard Hat

(X) Goggles

() Face Shield

() Chemical Eyeglasses

() None

() Other _____

Clothing

() Fully Encapsulating Suit

() Chemically Resistant
Splash Suit

() Apron, Specify _____

(X) Tyvek Coverall

() Saranex Coverall

() Coverall, Specify _____

() Other _____

() Other _____

Hand Protection

() Undergloves _____
Type

(X) Gloves NEOPRENE
Type

() Overgloves _____
Type

() None

() Other _____

Foot Protection

(X) Safety Boots
() Disposable Overboots
() Other

3. Monitoring Equipment

() CGI

() O₂ Meter

() Rad Survey

() Detector Tubes

Type: _____

(~~X~~) PID

() FID

() Other _____

() Other _____

D. Personnel Decontamination (Attach Diagram)

Required () Not Required (~~X~~)

Equipment Decontamination

Required () Not Required (~~X~~)

If required, describe and list equipment ONLY REQUIRED IF LEVELS OF CONTAMINATION EXCEED RECOMMENDED LEVELS (5 ppm GREATER THAN BACKGROUND ON HN_4). IF NECESSARY, SET UP TWO TUBS FOR BOOT AND GLOVE WASH, THE 1ST CONTAINING HTH, THE 2ND TRISODIUM PHOSPHATE. WASH BOOTS AND GLOVES IN BOTH TUBS AND RINSE WITH WATER. DISPOSE OF TYVICS IN PLASTIC BAGS AND ARRANGE FOR LATER DISPOSAL.

E. Personnel

<u>NAME</u>	<u>WORK LOCATION TITLE/TASK</u>	<u>MEDICAL CURRENT</u>	<u>FIT TEST CURRENT</u>
1. GLENN SMART	GEOLOGIST / SAFETY OFFICER	(X)	(X)
2. GERRY O'NEIL	GEOLOGIST	(X)	(X)
3. RON ALTHOUSE	TECHNICIAN	(X)	(X)
4. ROBERT RICHARD	TECHNICIAN	(X)	(X)
5.		()	()
6.		()	()
7.		()	()
8.		()	()
9.		()	()
10.		()	()

Site Safety Co-ordinator GLENN SMART

F. Activities Covered Under this Plan

Preliminary
Schedule

Task No.	Description
	INSTALLATION OF MONITORING WELLS
	DIGGING OF TEST PITS
	SAMPLING ABANDONED FUEL LINE HEADER PIPES

G. Subcontractor's Health and Safety Program Evaluation

Name and Address of Subcontractor: D.L. MAHER INC., CONCORD ST., NORTH READING MA.

AND ROBERT CHURCH, INC. SOUTH DENVIS, MA.

Activities to be Conducted by Subcontractor: Well Drilling AND TEST PIT

EXCAVATION

EVALUATION CRITERIA

Item.	EVALUATION CRITERIA		Comments
	<u>Adequate</u>	<u>Inadequate</u>	
Medical Surveillance Program	()	(X)	
Personal Protective Equipment Availability	(X)	()	
On-Site Monitoring Equipment Availability	(X)	()	
Safe Working Procedures Specification	(X)	()	
Training Protocols	()	(X)	
Ancillary Support Procedures (if needed)	(X)	()	
Emergency Procedures	(X)	()	
Evacuation Procedures Contingency Plan	(X)	()	
Decontamination Procedures Equipment	(X)	()	
Decontamination Procedures Personnel	(X)	()	

GENERAL HEALTH AND SAFETY PROGRAM EVALUATION: ADEQUATE (X) INADEQUATE ()

ADDITIONAL COMMENTS:

EVALUATION CONDUCTED BY: _____

DATE: _____

WESTON

H. Contingency Contacts

<u>Agency</u>	<u>Contact</u>	<u>Phone Number</u>
Fire Department	<u>Charles Bowman</u>	<u>968-4674</u>
Police Department	<u>Chief Kalinua</u>	<u>968-5208</u>
Health Department	<u>N/A</u>	<u>—</u>
Poison Control Center	<u>—</u>	<u>1-800-682-9211</u>
State Environmental Agency	<u>DEQE</u>	<u>—</u>
EPA-Regional Office	<u>N/A</u>	<u>—</u>
EPA-ERT. ICOM	<u>N/A</u>	<u>—</u>
Spill Contractor	<u>N/A</u>	<u>—</u>
State Police (Bourne)	<u>—</u>	<u>759-4458</u>
F.A.A.	<u>Control Tower</u>	<u>968-4444</u>
Civil Defense	<u>N/A</u>	<u>—</u>
On Site Coordinator	<u>GUINN SMART</u>	<u>—</u>
Site Telephone	<u>NONE</u>	<u>—</u>
Nearest Telephone	<u>AVAILABLE THROUGHOUT BASE</u> <u>(Location)</u>	<u>—</u>
Other	<u>—</u>	<u>—</u>

I. Contingency Plans

Spill, Accidental Release; Describe N/A

Fire Explosion; Describe N/A

Other; Describe N/A

Exit Routes, Communication Systems; Describe N/A



MEDICAL EMERGENCY

Name of Hospital Falmouth Hospital

Address: Tar-Helm Drive Phone No. 548-5300

Name of Contact _____

Address: _____ Phone No. _____

Route to Hospital: (Attach Map) Sandwich Rd - Rte 28 -
Jones Rd. - up hill

Travel Time
From Site (Minutes) 20 min.

Distance to
Hospital (Miles) 10

Name/Number of 24 Hr. Ambulance Service Pasa Service
968-4220

APPENDIX F

SAMPLE CHAIN-OF-CUSTODY RECORDS

Custody Transfer Record/Lab Work Request

Received By McDonald RFW Contact Kraybill
 Date 7/26/85 Date Due 8/16/85
 Assigned to McDonald Project Number 0650-05-28

SAMPLE IDENTIFICATION

ANALYSES REQUESTED

Sample No.	Client ID No.	Description	Date Collected	Container/Preservative	Pb	Rest.	Hachb	PCB	SO ₄	Cl	NO ₂	B/N/A
0010		NDE Sludge Tank	7/23/85	250 ml Poly	✓							
20		MW 3A	"	500 bottles		✓	✓	✓	✓	✓	✓	
30		MW 12A	"	"		✓	✓	✓	✓	✓	✓	
40		MW 2A	"	"		✓	✓	✓	✓	✓	✓	
50		MW 4	"	"		✓	✓	✓	✓	✓	✓	
60		MW 1	"	"		✓	✓	✓	✓	✓	✓	
70		MW 12	"	"		✓	✓	✓	✓	✓	✓	
80		header 7 *	"	"								✓
90		header 12 *	"	"								✓

SPECIAL INSTRUCTIONS: * Probably high concentrations. Shipped as restricted materials (ignitable)

Items/Reason	Relinquished By	Received By	Date	Time	Items/Reason	Relinquished By	Received By	Date	Time
Alga	McDonald	McDonald	7/24/85	1200	204	McDonald	McDonald	8/15/85	1040
30	McDonald	McDonald	7/27/85	0900					
40	McDonald	McDonald	7/27/85	0900					
50	McDonald	McDonald	7/27/85	0900					
60	McDonald	McDonald	7/27/85	0900					
70	McDonald	McDonald	7/27/85	0900					
80	McDonald	McDonald	7/27/85	0900					
90	McDonald	McDonald	7/27/85	0900					



Received By

Date:

Assigned to

8504.42/-

Custody Transfer Record/Lab Work Request

李一明

01/19/85

SAMPLE IDENTIFICATION

Client USAF/OTIS

Client Contact Jerry O'Neill

Phone Ext. 367

AFW Contact_

Date Due

Project Number 6629-05-28

ANALYSES REQUESTED[illegible]

SPECIAL INSTRUCTIONS: VOA Analysis is to include: MEK, MIBK, and Xylenes and meet detection limit(s) specified by EPA methods 601 and 602.

[illegible]

INVOICE NO.	ISSUED NAME	DATE	TIME	STATION	LOCATION	NO. OF CON-TRAINERS	REMARKS
0628-05-28	0719 ANKAS PHASE II						
<div style="display: flex; justify-content: space-between;"> <div> <p>RECEIVED BY</p> <p>12/13/84</p> <p>1443</p> </div> <div> <p>RECEIVED BY</p> <p>12/13/84</p> <p>1500</p> </div> </div>							
5-2	✓	✓	✓	✓	✓	5	HIGH CONCENTRATION
5-1	✓	✓	✓	✓	✓	5	HIGH CONCENTRATION
5-3	✓	✓	✓	✓	✓	1	ANALYZE FOR: NOA'S, BASE NEUTRAL, ACID EXTRACTABLES, METALS
5-4	✓	✓	✓	✓	✓	1	
5-5	✓	✓	✓	✓	✓	1	
5-6	✓	✓	✓	✓	✓	1	
5-7	✓	✓	✓	✓	✓	1	

WESTON ANALYTICAL LABORATORIES

SAMPLE HANDLING SAFETY INFORMATION

(samples will not be processed unless item 7 - B is signed)

<p>1. CLIENT NAME <u>USAF</u></p> <p>W.O. No: <u>0625-0528</u></p> <p>Location (Site) (City/State): <u>0715 AFB, MO.</u></p> <p>Phone: () Contact</p>	<p>2. SAMPLING PERSONNEL:</p> <p><u>GLENN SMART</u> <u>228-1334</u> <small>(name)</small> <small>(phone ext.)</small></p> <p>Date Sampled. <u>12</u> <u>13</u> <u>84</u> <small>M</small> <small>D</small> <small>Y</small></p> <p>Project Manager: <u>FRED BOPP</u> Ext. <u>403</u></p>																											
<p>3. SPECIAL HANDLING:</p> <p>What Safety Precautions Were Taken During Sampling?</p> <p>A. Personal Protective Equipment Used</p> <p>_____</p> <p>_____</p> <p>B. Other: _____</p> <p>_____</p> <p>Have The Exterior of the Sample Bottles Been Decontaminated? Y / N</p>	<p>4. SUSPECTED HAZARDOUS COMPONENTS: (Not a Parameter List)</p> <p><u>PETRO CHEMICALS (FUELS)</u></p> <p>_____</p> <p>Suspected Levels:</p> <p>Low _____</p> <p>Medium _____</p> <p>High <u>✓</u></p>																											
<p>5. SAMPLE MATRIX:</p> <p>_____ SOIL <u>NEARLY</u> WATER</p> <p>_____ GAS <u>NEARLY PURE</u> OTHER</p> <p> <u>PROD. CT</u></p>	<p>6. LIST ONLY SAMPLES WHICH PERTAIN TO THE INFORMATION LISTED IN ITEM 4.</p> <table style="width: 100%;"> <thead> <tr> <th style="width: 33%;">Sample No.</th> <th style="width: 33%;">Sample No.</th> <th style="width: 33%;">Sample No.</th> </tr> </thead> <tbody> <tr> <td><u>S-1</u></td> <td></td> <td></td> </tr> <tr> <td><u>S-2</u></td> <td></td> <td></td> </tr> <tr><td> </td><td></td><td></td></tr> <tr><td> </td><td></td><td></td></tr> <tr><td> </td><td></td><td></td></tr> <tr><td> </td><td></td><td></td></tr> <tr><td> </td><td></td><td></td></tr> <tr><td> </td><td></td><td></td></tr> </tbody> </table>	Sample No.	Sample No.	Sample No.	<u>S-1</u>			<u>S-2</u>																				
Sample No.	Sample No.	Sample No.																										
<u>S-1</u>																												
<u>S-2</u>																												
<p>7. A. RELINQUISHED BY:</p> <p><u>[Signature]</u> <u>12/13/84</u> <small>(signature)</small></p> <p>B. RECEIVED BY:</p> <p>_____</p> <p><small>(signature)</small></p> <p>Date: _____</p> <p>Time _____ am _____ pm</p>																												

[illegible]



inter-office memorandum

TO: Project File

DATE: 4 September 1985

FROM: Glenn Smart

A handwritten signature in cursive script, appearing to read "Glenn R. Smart".

SUBJECT: Chain of Custody form for test pit sampling
on 10/2/1984

W.O.No.: 0628-05-28

On 10/2/84, WESTON personnel collected soil samples from test pits 6a, 7a, and 8a at the so-called "AVGAS Dump Site" at Otis Air National Guard Base, Massachusetts. The samples were sent to the WESTON laboratory in West Chester, Pennsylvania with other samples collected elsewhere on the base. The accompanying chain of custody form listed the parameters that the samples were to be analyzed for (phenol, lead, and hydrocarbons by GC scan), but the test pit identification numbers were inadvertently omitted. Information in the field logbook indicates that sample 6a was taken at 1135 at approximately five feet below ground level, sample 7a was taken at 1148 from between 1-3 feet below ground surface and test pit 8a was sampled at approximately two feet below ground surface.

CHAIN OF CUSTODY RECORD

PROJECT NO.		ESTIMATE NAME		OTIS AUG MAS		NO. OF CONTAINERS		REMARKS	
SAMPLING SIGNATURES		STATION LOCATION		DATE		TIME		REMARKS	
WELL-1	11/2/64	1000	✓	WELL # 1	11	✓	SEE ATTACHED	DATE	TIME
WELL-2	11/16/64	1200	✓	WELL # 2-A	11	✓	SHEET FOR	DATE	TIME
WELL-3	11/16/64	1430	✓	WELL # 3-A	11	✓	ANALYTICAL PROTOCOLS	DATE	TIME
WELL-4	11/16/64	1700	✓	WELL # 4	11	✓		DATE	TIME
WELL-5	11/16/64	1000	✓	WELL # 5	8	✓		DATE	TIME
WELL-6	11/16/64	1730	✓	WELL # 6	9	✓		DATE	TIME
WELL-7	11/16/64	1500	✓	WELL # 7	8	✓		DATE	TIME
WELL-8	11/16/64	1730	✓	WELL # 8	6	✓		DATE	TIME
WELL-9	11/17/64	1500	✓	WELL # 9	6	✓		DATE	TIME
WELL-10	11/17/64	1230	✓	WELL # 10	5	✓		DATE	TIME
WELL-10A	11/17/64	1230	✓	WELL # 10-A	5	✓		DATE	TIME
WELL-11	11/17/64	1230	✓	WELL # 11	5	✓		DATE	TIME
WELL-12	11/17/64	1230	✓	WELL # 12	11	✓		DATE	TIME
RECEIVED BY		DATE		TIME		RECEIVED BY		REMARKS	
J. C. [Signature]		11/10/64				J. C. [Signature]		RECEIVED BY	
RECEIVED BY		DATE		TIME		RECEIVED BY		REMARKS	
RECEIVED BY		DATE		TIME		RECEIVED BY		REMARKS	

BY GRS DATE 10/26/84 DIV 1530 SHEET 1 OF 1
 CHKD BY _____ DATE _____ DEPT _____ W.O. NO. 0628-05-28
 PROJECT 0775 AIR NATIONAL GUARD BASE, MA
 SUBJECT ANALYTICAL PROTOCOLS FOR WELL SAMPLING

	RAW1	RAW2	RAW3A	RAW4	RAW5	RAW6	RAW7	RAW8	RAW9	RAW10	RAW11	TOTAL
HARDNESS	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
TOTAL DISSOLVED IRON	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
SULFATE	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
CHLORIDE	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
NITRATE NITROGEN	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
TOTAL KJELDAHL NITROGEN	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
AMMONIA NITROGEN	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
TUC	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
PHENOL	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
VOA	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
XYLENE	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
METHYL ETHYL KETONE	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
METHYL ISOBUTYL KETONE	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
OIL & GREASE	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
GC HYDROCARBON SCAN	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
LEAD	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4
IR SCAN FOR PETROLEUM HYDROCARBONS	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	(✓)	4

+ Extras for duplicates & Blanks
 NOTE WELL #12 DO SAME
 ANALYTICAL PROTOCOLS AS

CHAIN OF CUSTODY RECORD

Shipper Name: Steven I Michelson
 Address: 2 Chenell Dr., Concord NH 03301
 Number Street City State Zip
 Collector's Name: Steven I Michelson Telephone (603) 728-1334
 Address of Collection: OTIS AAB, MASS 02542

Collector Sample Number	Date of Collection	Time of Collection	Collection Location	Analyses Requested
SludgeWtr	2/16/84	Pm	OTIS	Oil + Grease
SludgeWtr			ANG	TOX

Sample Receiver:

1. Roy F Weston Inc., 2 Chenell Dr., Concord NH 03301
Name and address of organization receiving sample
2. _____
3. _____
4. _____

Chain of Possession:

- | | | | |
|----|---------------------------------|--------------------------------------|-----------------------------------|
| 1. | <u>[Signature]</u>
Signature | <u>Asst Proj. Geologist</u>
Title | <u>2/16/84</u>
Inclusive Dates |
| 2. | <u>[Signature]</u>
Signature | <u>Lola M. [Signature]</u>
Title | <u>2/22/84</u>
Inclusive Dates |
| 3. | _____
Signature | _____
Title | _____
Inclusive Dates |
| 4. | _____
Signature | _____
Title | _____
Inclusive Dates |

CLIENT OTIS AFB

PRIORITY/HAZARD _____

WO#/PO# C628-05-28-aSUBMITTED BY E. Anderson

DATE RECEIVED _____

MISC. _____

RFW#	SAMPLE DESCRIPTION	DATE COLLECTED	PA	PA	PA	PA	PA	PA	PA
1.	MW-1	2/7/84	TOC	TOX	C/L	HEAV	PCB	PEST	INSTR
2.	MW-1-D	2/7/84							2 IN CUTAL CARD
3.	MW-2A	2/7/84							5 IN CUTAL CARD
4.	MW-3A	2/7/84							1 IN CUTAL CARD
5.	MW-4	2/8/84							
6.	MW-5	2/8/84	✓	✓	✓	✓	✓	✓	✓
7.	MW-5-D		TOC	TOX	C/L	PCB	LEAD		
8.	MW-6		✓	✓	✓	✓	✓	✓	
9.	MW-7		TOC	TOX	C/L	LEAD			
11.	KDI SLUDGE PIT (LIQUID)		TOX	C/L	LEAD	TOC			
12.	KDI SLUDGE PIT (SOIL)		TOX	C/L	LEAD				
13.									
14.									
15.									
16.	NOTE: TOX FOR KDI SLUDGE PIT 11C-D (FILLING) 1/2								1/2
17.	(2) C/L FOR KDI SLUDGE PIT 11C-D								1/2
18.									
19.									
20.									
21.									
22.									
23.									
24.									
25.									



BY JRA DATE 2/9/84 DIV _____ SHEET 3 OF 4
CHKD BY _____ DATE _____ DEPT _____ W.O. NO. _____
PROJECT OTIS AFB
SUBJECT NDI SLUDGE PIT

2/8/84 - NDI - TOOK WATER SAMPLE FROM PIT WITH
SS. SAMPLER. SAMPLED FOR TOC, TOX, O/G LEAD

TOOK SLUDGE SAMPLE WITH CLAM SAMPLER APPROX
1' INTO SLUDGE LAYER, SAMPLED FOR TOX, O/G
LEAD



inter-office memorandum

TO: Richard Kraybill

DATE: September 4, 1985

FROM: Victoria K. Dondero *[Signature]*

SUBJECT: OTIS 8402-822 SAMPLES

W. O. No.:

Due to the lack of a log-in sheet or computer record of these samples, it is resolved that these samples had been received prior to 27 February 1984. It can be documented that this date is when Oil & Grease analyses were begun.

VKD/eb

CHAIN OF CUSTODY RECORD

Shipper Name: Ron F. Weston Inc

Address: 2 Chenell Dr Concord NH 03301
 Number Street City State Zip

Collector's Name: R.L. Krumboltz Telephone 603 228 1334

Address of Collection: OTIS AFB, MA

2 sample bottles @

Collector Sample Number	Date of Collection	Time of Collection	Collection Location	Analyses Requested
10-1	11/30/83	PM	15'-1.5'	TOX, O&G (IR) Pb CITA
10-2			2.5-3.5'	
10-3			7'	
11-1			0-2.5	
11-2			4'	
11-3			9'	

Sample Receiver:

1. Name and address of organization receiving sample
2. _____
3. _____
4. _____

Chain of Possession:

1. R.L. Krumboltz Sr. Hydro/PM 11/20/83 12/1/83
 Signature Title Inclusive Dates
2. _____
 Signature Title Inclusive Dates
3. _____
 Signature Title Inclusive Dates
4. _____
 Signature Title Inclusive Dates

CHAIN OF CUSTODY RECORD

2073

Shipper Name: Roy F. Weston Inc.Address: 2 Chenell Dr. Concord MA 03301
Number Street City State ZipCollector's Name: R. L. Kraybill Telephone (603) 228 1334Address of Collection: OTIS AFB, MA

2 sample bottles @

Collector Sample Number	Date of Collection	Time of Collection	Collection Location	Analyses Requested
12-1	11/30/83	PM	3.5'	TOX O&G (IR) Pb
12-2			8.5'	
13-1			4'	
14-1			4'	
21-1	12/1/83	AM	1-1.5'	0.5-1.0' NOT TOX O&G (IR) Pb
22-1			1-1.5'	

Sample Receiver:

- Name and address of organization receiving sample
-
-
-

Chain of Possession:

- Signature: R. L. Kraybill Title: Sen Hydro/P.M. Inclusive Dates: 11/30-12/1/83
- Signature _____ Title _____ Inclusive Dates _____
- Signature _____ Title _____ Inclusive Dates _____
- Signature _____ Title _____ Inclusive Dates _____

CHAIN OF CUSTODY RECORD

303

Shipper Name: Roy F Weston Inc
 Address: 2 Chenell Dr Concord NH 03301
Number Street City State Zip
 Collector's Name: R.L. Kuybick Telephone 603 228 1334
 Address of Collection: OTIS AFB, Md.

2 sample bottles @

Collector Sample Number	Date of Collection	Time of Collection	Collection Location	Analyses Requested
26-1	12/1/83	PM	2.0'	EFTA TOX O&G (IR) Pb
33-1			5.5'	

Sample Receiver:

- Name and address of organization receiving sample
-
-
-

Chain of Possession:

- | | | | |
|----|----------------------------------|----------------------------|---|
| 1. | <u>R.L. Kuybick</u>
Signature | <u>Engr. / PM</u>
Title | <u>11/30 - 12/1/83</u>
Inclusive Dates |
| 2. | Signature | Title | Inclusive Dates |
| 3. | Signature | Title | Inclusive Dates |
| 4. | Signature | Title | Inclusive Dates |

CLIENT CFIA H&S HEP

PRIORITY/HAZARD _____

WO#/PO# 0628-05-28

SUBMITTED BY Rich - Campbell

DATE RECEIVED 12/6

MISC: 001 641

RFW#	SAMPLE DESCRIPTION	DATE COLLECTED	PA	PA	PA	PA	PA	PA	PA
10226	TP-11 9'		0/6	TOX	Pb				
10227	TP-10 .5-1.5'								
10228	TP-10 7'								
10229	TP-10 2.5-3.5'								
10230	TP-22 1-1.5'								
10231	TP-26 2'								
10233	TP-21 0.5-1.0								
10234	TP-14 4'								
10235	TP-13 4'								
10236	TP-12 8.5' <i>one taken transferred to another bottle</i>								
10237	TP-33 5.5'								
10238	TP-12 3.5'								
10239	TP-11 0-2.5'								
10240	TP-11 4'								
5.									
16.									
17.									
18.									
19.									
20.									
21.									
22.									
23.									
24.									
25.									

WESTON

DESIGNERS CONSULTANTS

RFW #	Client - Sample Description/ I.D.	Chain Custody	Date/ Logged by	Date Comp.	Date Disc.
10211	G.M. INLET 1300		MA		
10212	G.M. OUTLET 1700				
10213	G.M. OUTLET 1300				
10214	ARCO Eff.		12-7-72		
10215	Proctor & Gamble		12/8/03		
10216					
10217					
10218					
10219					
10220	Water Units 624		12/8/03		
10221					
10222					
10223					
10224					
10225	Appleton AP-7				
10226	CF TA OTS AFB TP-11 9'				
10227					
10228					
10229					
10230					
10231					
10232	UNUSU				
10233	OTW AFB TP-21 5-1.0				
10234					
10235					
10236					

5775					
5776					
5777					

WESTON

DESIGNERS CONSULTANTS

RFW #	Client - Sample Description/ I.D.	Chain Custody	Date/ Logged by	Date Comp.	Date Disc.
10237	OTIS AFB TP-33 5.5'		12/8 JLD		
10238	TP-12 3.5'				
10239	TP-11 1-2.5				
10240	TP-11 4'				
10241	Handcom AFB 0-1				
10242	0-2				
10243	0-3				
10244	0-4				
10245	0-5				
10246	Field Blk				
10247	Inn College Pool RACT		12/9 PCH		
10248	1000 Keep Drinking Water		12/9 JLD		
10249	Prioron & Gamble		12/9/83 KL		
10250					
10251					
10252					
10253					
10254	BUTZ + WILSON 312 Extra Rd		12/9 JLD		
10255	ENTERPRISE S-7	Ma			
10256	S-8				
10257	S-10				
10258	S-11				
10259	S-12				
10260	64-D				
10261	57-D				
10262	55-D				

75					
76					
77					

APPENDIX G

LABORATORY ANALYTICAL METHODS

Table G-1

Analytical Methods and Required Detection Limits

<u>Analytes</u>	<u>Level of Detection Required</u>		<u>Contract Method</u>
Total Organic Carbon (TOC)	1	mg/L	EPA 415.1
Total Organic Halogens (TOX)	5	uf/L (w); 5 ug/g (s)	EPA 9020
Oil and Grease by Infrared Method (O&G)	0.1	mg/L (w); 100 ug/g (s)	EPA 413.2
Cyanide (Cn)	10	ug/L	EPA 335.2
Phenols	1	ug/L (w); 1 ug/g (s)	EPA 420.1
Polychlorinated Biphenyls (PCB)	0.25	ug/L	EPA 608
Iron (total dissolved) (Fe)	100	ug/L	EPA 200.7
Copper (Cu)	50	ug/L	EPA 200.7
Cadmium	10	ug/L	EPA 213.2
Chromium (Cr)	50	ug/L	EPA 200.7
Lead (Pb)	20	ug/L (w); 2 ug/g (s)	EPA 239.2
Arsenic (As)	10	ug/L	EPA 206.2
Nickel (Ni)	100	ug/L	EPA 200.7
Endrin	0.02	ug/L	SM 509A
Lindane	0.01	ug/L	SM 509A
Methoxychlor	0.2	ug/L	SM 509A
Toxaphene	1.0	ug/L	SM 509A
2,4-D	0.06	ug/L	SM 509B
2,4,5-TP Silvex	0.02	ug/L	SM 509B
Xylene	1	ug/L	EPA 624
Methyl isobutyl ketone (MIBK)	1	ug/L	EPA 624
Methyl ethyl ketone (MEK)	1	ug/L	EPA 624
Sulfate	1	ug/L	EPA 300.0
Chloride	1	ug/L	EPA 300.0
Hardness	--		EPA 130.2
Infrared Scan (IR scan)	--		EPA 418.1
Ammonia as Nitrogen	--		EPA 350.3
Hydrocarbon GC Scan	--		(see description in App. G)
Total Kjeldahl Nitrogen	--		EPA 351.4
Nitrate as Nitrogen	--		EPA 300.0
Volatile Organic Compounds (VOA)	(1)		EPA 601/602
Base/Neutrals and Acids	(2)		EPA 625

(w) = water

(s) = soil

(1) = Detection levels for volatile aromatics and volatile halocarbons shall be as specified in EPA Methods

(2) = Detection levels for base/neutrals and acids shall be as specified in EPA Method 625.



inter-office memorandum

TO: Judith Porta

DATE: 28 January 1985

FROM: Carter Nulton *CN*

SUBJECT: OTIS AFB SAMPLES
RFW#'s 8412-992-0010 - 0070
(CLIENT I.D. S-1 to S-7)

W. O. No.:

Sample 0010 was extracted with hexane and analyzed by capillary column GC/FID (30 meter DB-5); samples 0020 - 0070 were diluted 1:100 in hexane and analyzed using the same conditions. The resulting GC profiles of 0010 and 0020 were compared to those obtained from the pure products and the following observations are made:

1. 0010 - is similar to 0050 (see Fig. 1) except that the "high ends" (peaks at retention times 61.34, 63.59, 69.67, 77.29 and 84.16 on Fig. 1-4) in 0010 are of lower concentration than in 0050. The concentration of 0010 calculated on the basis of selected lower molecular weight peaks (A-E on Fig. 1) is 480 mg/L. If the "high ends" are used, the concentration is 20 mg/L.
2. 0020 - is similar to 0050 (see Fig. 2) except that the lower molecular weight peaks (those eluting between the solvent and 50 minutes) are gone.

Sample 0020 is completely miscible in hexane.

CN:bwm

Fig. 1A - Sample 0010

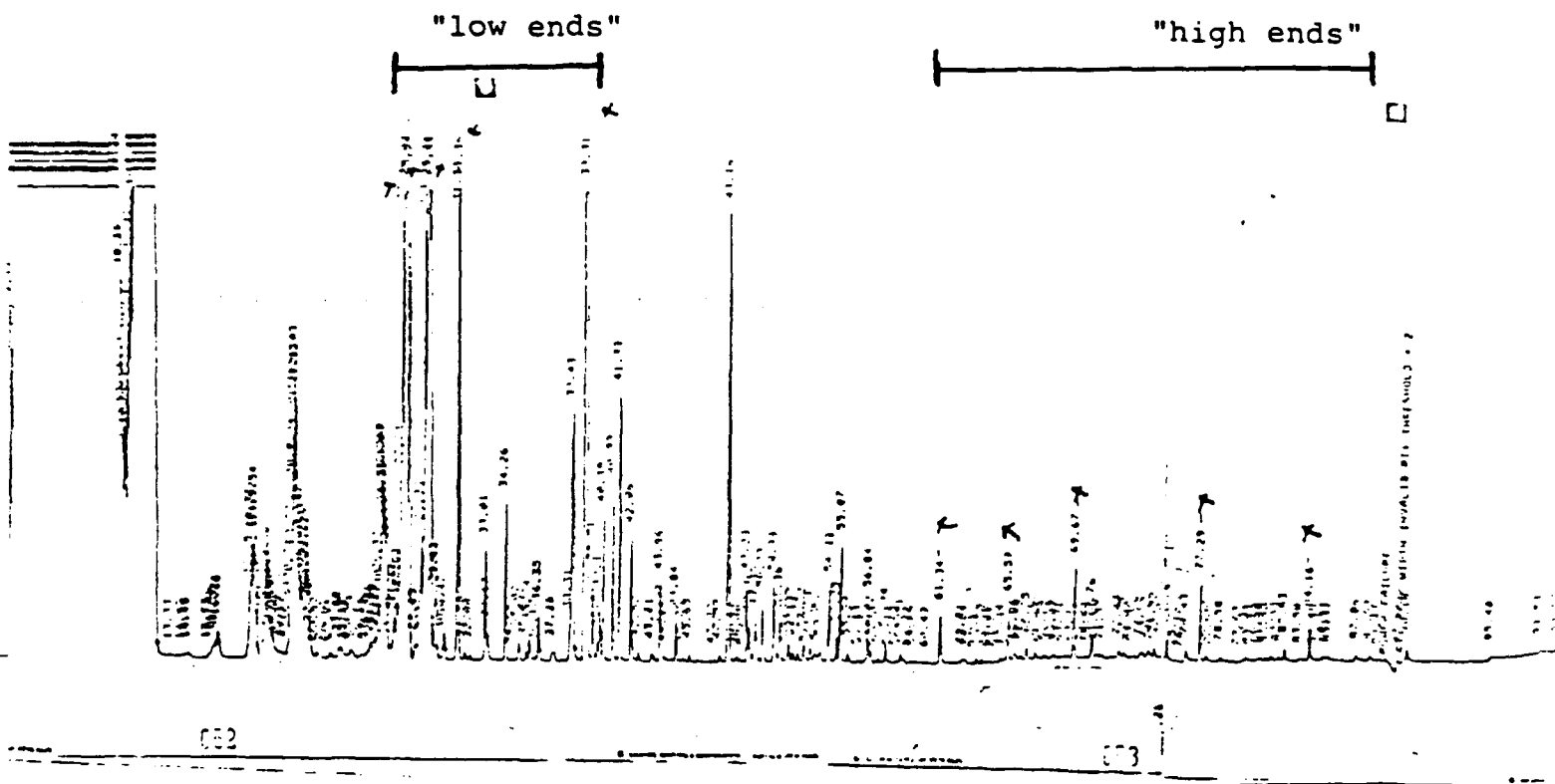


Fig. 1B - Sample 0050

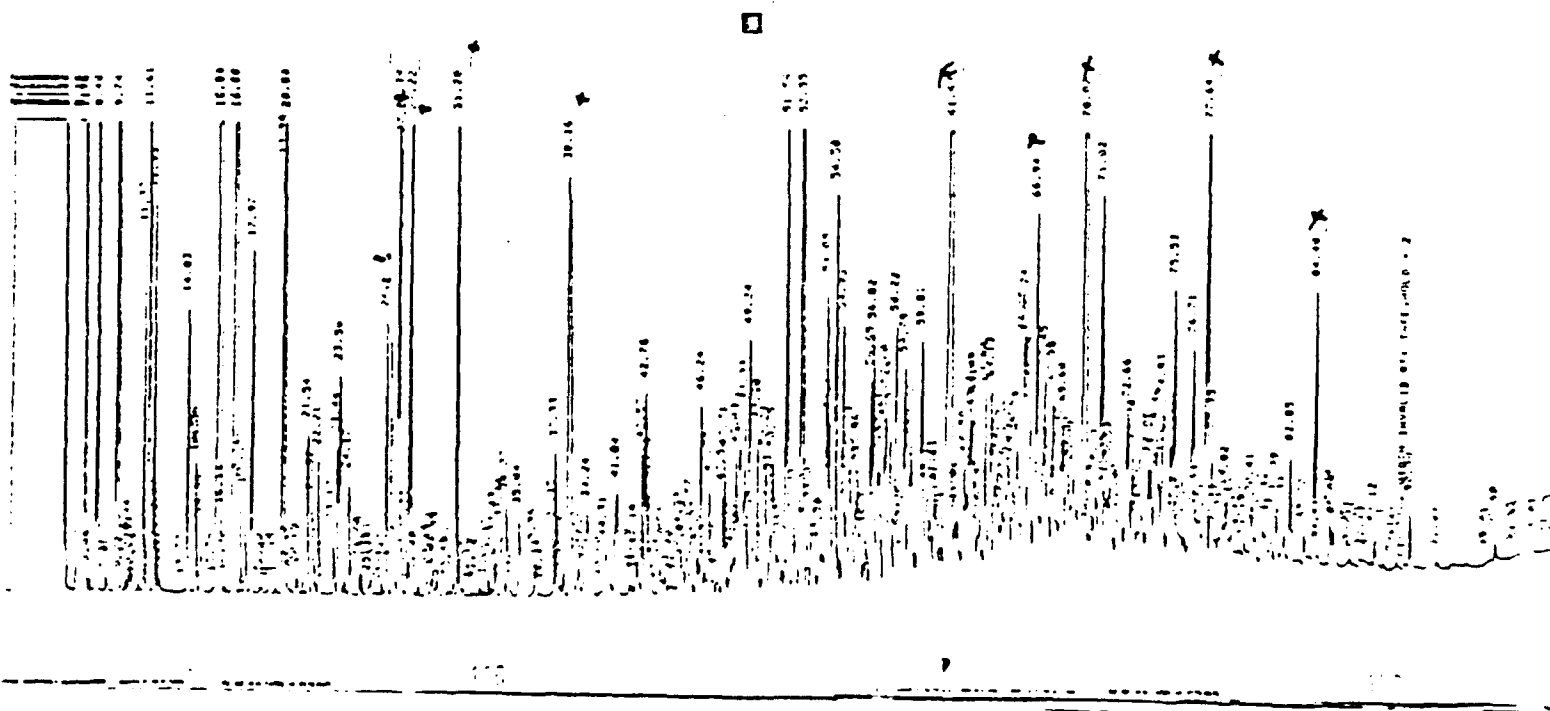


Fig. 2A - Sample 0020

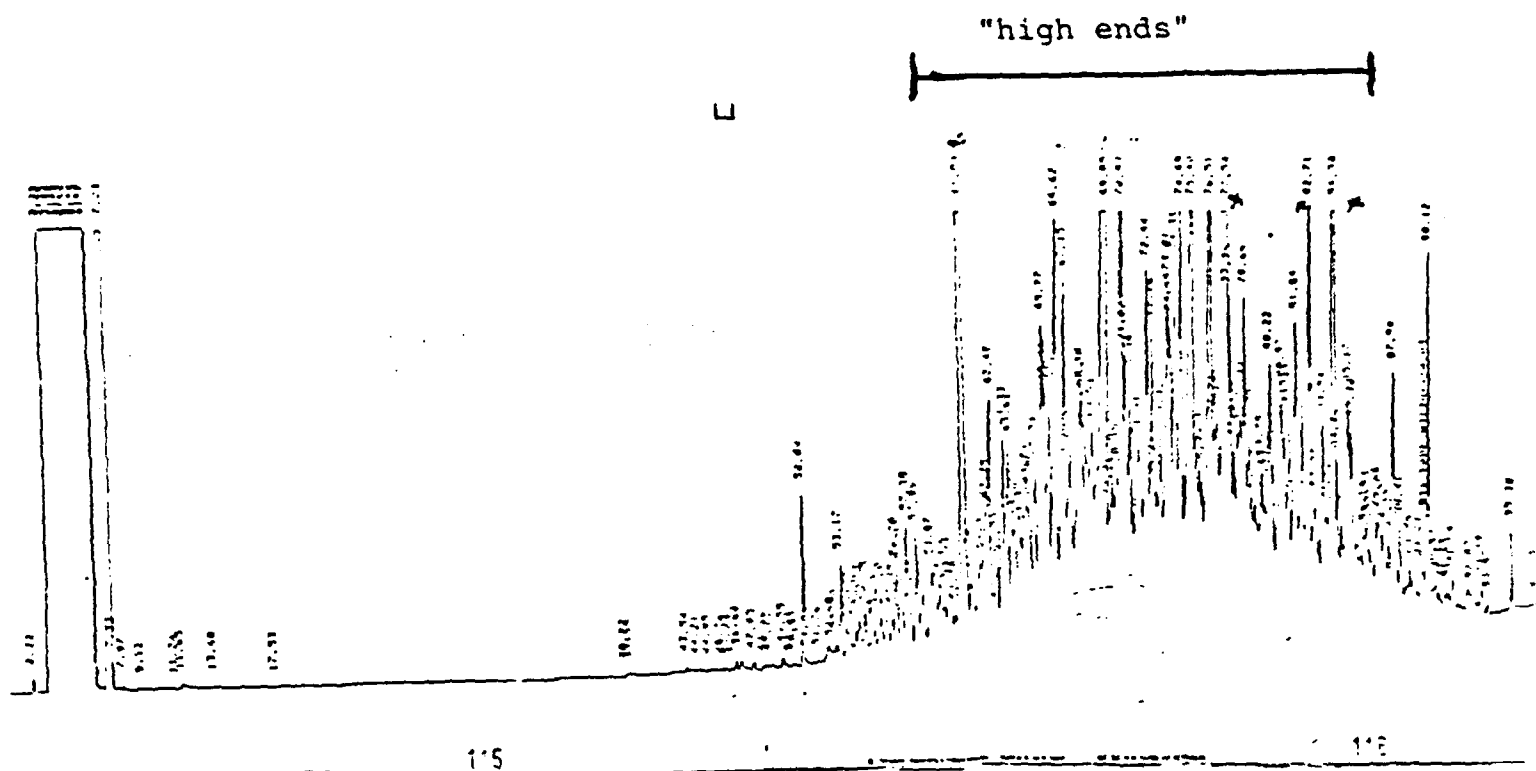
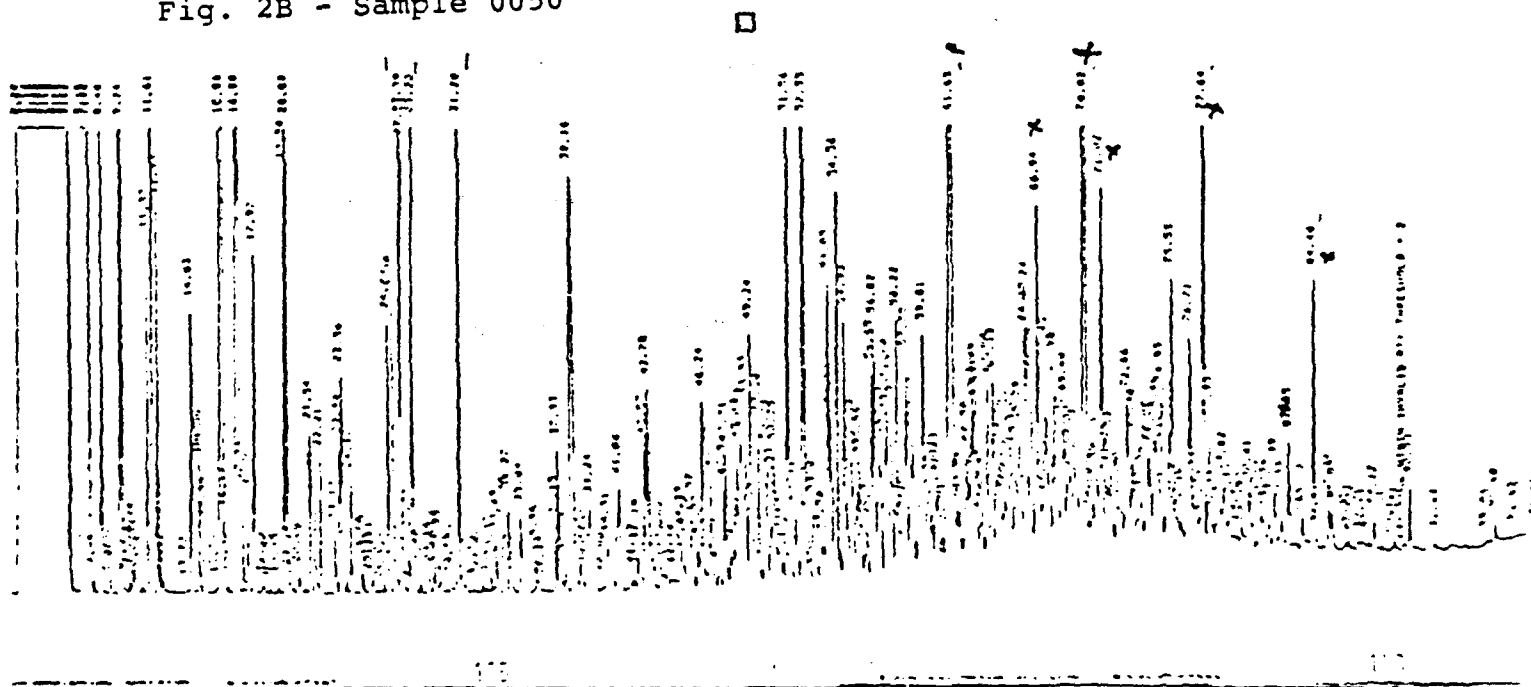


Fig. 2B - Sample 0050





OIL AND GREASE METHOD

The method used by the WESTON Laboratory for U.S. Air Force contract analyses through 13 September 1985 is described in the following pages.



Scope

This method is applicable to the determination of oil and grease in water samples.

Summary of Method

Oil and grease is extracted from water with 1,1,2-trichloro-1,2,2-trifluoroethane. The extract is analyzed by infrared at 2930 cm^{-1} .

Apparatus

1. Infrared spectrophotometer
2. 50 mm liquid IR cell
3. Magnetic Stirrer
4. 25 ml pipet

Reagents

1. 1,1,2-trichloro-1,2,2-trifluoroethane (freon)
2. Paraffin oil, NF

Procedure

1. 25 ml of 1,1,2-trichloro-1,2,2-trifluoroethane are added directly to the 1 liter sample container with a teflon-coated magnetic stirring bar.
2. The mixture is stirred at least one hour.
3. The mixture is allowed to settle, and the freon is withdrawn with a pipet.
4. The freon is placed in the IR cell and the absorbance is read.



Calibration

1. Prepare calibration standards from 4 to 40 mg/l by weighing paraffin oil into freon.
2. Obtain absorbances at 2930 cm^{-1} for each of the calibration standards.
3. Plot absorbances vs. concentration.

Calculations

1. Determine the extract concentrations directly from the calibration curve.
2. Calculate sample concentrations from:

$$\text{conc. (mg/l)} = \frac{A \times B}{C}$$

where:

A = Concentration of extract determined from calibration curve, in mg/l

B = ml of freon used to extract

C = Volume of water sample extracted, in ml

¹ Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.

² When any sample is to be shipped by common carrier or sent through the United States Mails, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172). The person offering such material for transportation is responsible for ensuring such compliance. For the preservation requirements of Table II, the Office of Hazardous Materials, Materials Transportation Bureau, Department of Transportation has determined that the Hazardous Materials Regulations do not apply to the following materials: Hydrochloric acid (HCl) in water solutions at concentrations of 0.04% by weight or less (pH about 1.96 or greater); Nitric acid (HNO₃) in water solutions at concentrations of 0.15% by weight or less (pH about 1.82 or greater); Sulfuric acid (H₂SO₄) in water solutions at concentrations of 0.35% by weight or less (pH about 1.15 or greater); and Sodium hydroxide (NaOH) in water solutions at concentrations of 0.08% by weight or less (pH about 12.30 or less).

³ Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analyses and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer time, and has received a variance from the Regional Administrator under § 136.3(e). Some samples may not be stable for the maximum time period given in the table. A permittee, or monitoring laboratory, is obligated to hold the sample for a shorter time if knowledge exists to show that this is necessary to maintain sample stability. See § 136.3(e) for details.

⁴ Should only be used in the presence of residual chlorine.

⁵ Maximum holding time is 24 hours when sulfide is present. Optionally all samples may be tested with lead acetate paper before pH adjustments in order to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

⁶ Samples should be filtered immediately on-site before adding preservative for dissolved metals.

⁷ Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.

⁸ Sample receiving no pH adjustment must be analyzed within seven days of sampling.

⁹ The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.

¹⁰ When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for seven days before extraction and for forty days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re the requirement for thiosulfate reduction of residual chlorine), and footnotes 12, 13 (re the analysis of benzidine).

¹¹ If 1,2-diphenylhydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.

¹² Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.

¹³ For the analysis of diphenylhydrazine, add 0.008% Na₂S₂O₄ and adjust pH to 7-10 with NaOH within 24 hours of sampling.

¹⁴ The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldim, add 0.008% Na₂S₂O₄.

8. Appendices A, B, and C are added to Part 136 to read as follows:

APPENDIX A TO PART 136—METHODS FOR ORGANIC CHEMICAL ANALYSIS OF MUNICIPAL AND INDUSTRIAL WASTEWATER.

Method 601—Purgeable Halocarbons

1. Scope and Application

1.1 This method covers the determination of 29 purgeable halocarbons.

The following parameters may be determined by this method:

Parameter	STCET No.	CAS No.
Bromodichloromethane	32101	75-27-4
Bromotom	32104	75-25-2
Bromomethane	34413	74-83-9
Carbon tetrachloride	32102	56-23-5
Chlorobenzene	34301	108-90-7
Chloroethane	34311	75-00-3
2-Chloroethylvinyl ether	34576	100-75-6
Chloroform	32108	67-66-3
Chloromethane	34418	74-87-3
Dibromochloromethane	32105	124-48-1
1,2-Dichlorobenzene	34536	95-50-1
1,3-Dichlorobenzene	34566	541-73-1
1,4-Dichlorobenzene	34571	106-46-7
Dichlorodifluoromethane	3446	75-71-8
1,1-Dichloroethane	3445	75-34-3
1,2-Dichloroethane	3453	107-06-2
1,1-Dichloroethane	3450	75-35-4
trans-1,2-Dichloroethane	34546	156-60-5
1,2-Dichloropropane	34541	78-87-5
cis-1,3-Dichloropropene	34704	10061-01-5
trans-1,3-Dichloropropene	34699	10061-02-6
Methylene chloride	34/23	75-09-2
1,1,2,2-Tetrachloroethane	34518	79-34-5
Tetrachloroethane	34475	127-18-4
1,1,1-Trichloroethane	34508	71-55-6
1,1,2-Trichloroethane	34511	79-00-5
Tetrachloroethane	39180	79-01-6
Tetrachlorofluoromethane	34486	75-69-4
Vinyl chloride	39715	75-01-4

1.2 This is a purge and trap gas chromatographic (GC) method applicable to the determination of the compounds listed above in municipal and industrial discharges as provided under 40 CFR 136.1. When this method is used to analyze unfamiliar samples for any or all of the compounds above, compound identifications should be supported by at least one additional qualitative technique. This method describes analytical conditions for a second gas chromatographic column that can be used to confirm measurements made with the

primary column. Method 824 provides gas chromatograph/mass spectrometer (GC/MS) conditions appropriate for the qualitative and quantitative confirmation of results for most of the parameters listed above.

1.3 The method detection limit (MDL, defined in Section 12.1) ¹ for each parameter is listed in Table 1. The MDL for a specific wastewater may differ from those listed, depending upon the nature of interferences in the sample matrix.

1.4 Any modification of this method, beyond those expressly permitted, shall be considered as a major modification subject to application and approval of alternate test procedures under 40 CFR 136.4 and 136.5.

1.5 This method is restricted to use by or under the supervision of analysts experienced in the operation of a purge and trap system and a gas chromatograph and in the interpretation of gas chromatograms. Each analyst must demonstrate the ability to generate acceptable results with this method using the procedure described in Section 8.2.

2. Summary of Method

2.1 An inert gas is bubbled through a 5-mL water sample contained in a specially-designed purging chamber at ambient temperature. The halocarbons are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent trap where the halocarbons are trapped. After purging is completed, the trap is heated and backflushed with the inert gas to desorb the halocarbons onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate the halocarbons which are then detected with a halide-specific detector. ^{2,3}

2.2 The method provides an optional gas chromatographic column that may be helpful in resolving the compounds of interest from interferences that may occur.

3. Interferences

3.1 Impurities in the purge gas and organic compounds outgassing from the plumbing ahead of the trap account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks as described in Section 8.1.3. The use of non-Teflon plastic

tubing, non-Teflon thread sealants, or flow controllers with rubber components in the purge and trap system should be avoided.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly fluorocarbons and methylene chloride) through the septum seal into the sample during shipment and storage. A field reagent blank prepared from reagent water and carried through the sampling and handling protocol can serve as a check on such contamination.

3.3 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. To reduce carry-over, the purging device and sample syringe must be rinsed with reagent water between sample analyses. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high organohalide levels, it may be necessary to wash out the purging device with a detergent solution, rinse it with distilled water, and then dry it in a 105°C oven between analyses. The trap and other parts of the system are also subject to contamination; therefore, frequent bakeout and purging of the entire system may be required.

4. Safety

4.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of material data handling sheets should also be made available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available and have been identified ^{4,5} for the information of the analyst.

4.2 The following parameters covered by this method have been tentatively classified as known or suspected, human or mammalian carcinogens: carbon tetrachloride, chloroform, 1,4-dichlorobenzene, and vinyl chloride. Primary standards of these toxic compounds should be prepared in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds.

5. Apparatus and Materials

5.1 Sampling equipment, for discrete sampling.

5.1.1 Vial—25-mL capacity or larger, equipped with a screw cap with a hole in the center (Pierce #13075 or equivalent). Detergent wash, rinse with tap and distilled water, and dry at 105 °C before use.

5.1.2 Septum—Teflon-faced silicone (Pierce #12722 or equivalent). Detergent wash, rinse with tap and distilled water, and dry at 105 °C for 1 h before use.

5.2 Purge and trap system—The purge and trap system consists of three separate pieces of equipment: a purging device, trap, and desorber. Several complete systems are now commercially available.

5.2.1 The purging device must be designed to accept 5-mL samples with a water column at least 3 cm deep. The gaseous head space between the water column and the trap must have a total volume of less than 15 mL. The purge gas must pass through the water column as finely divided bubbles with a diameter of less than 3 mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. The purging device illustrated in Figure 1 meets these design criteria.

5.2.2 The trap must be at least 25 cm long and have an inside diameter of at least 0.105 in. The trap must be packed to contain the following minimum lengths of adsorbents: 1.0 cm of methyl silicone coated packing (Section 6.3.3), 7.7 cm of 2,6-diphenylene oxide polymer (Section 6.3.2), 7.7 cm of silica gel (Section 6.3.4), 7.7 cm of coconut charcoal (Section 6.3.1). If it is not necessary to analyze for dichlorodifluoromethane, the charcoal can be eliminated, and the polymer section lengthened to 15 cm. The minimum specifications for the trap are illustrated in Figure 2.

5.2.3 The desorber must be capable of rapidly heating the trap to 180 °C. The polymer section of the trap should not be heated higher than 180 °C and the remaining sections should not exceed 200 °C. The desorber illustrated in Figure 2 meets these design criteria.

5.2.4 The purge and trap system may be assembled as a separate unit or be coupled to a gas chromatograph as illustrated in Figures 3 and 4.

5.3 Gas chromatograph—An analytical system complete with a temperature programmable gas chromatograph suitable for on-column injection and all required accessories including syringes, analytical columns, gases, detector, and strip-chart recorder. A data system is recommended for measuring peak areas.

5.3.1 Column 1—8 ft long x 0.1 in. ID stainless steel or glass, packed with 1% SP-1000 on Carbowax B (60/80 mesh) or

equivalent. This column was used to develop the method performance statements in Section 12. Guidelines for the use of alternate column packings are provided in Section 10.1.

5.3.2 Column 2—8 ft long x 0.1 in. ID stainless steel or glass, packed with chemically bonded n-octane on Porasil-C (100/120 mesh) or equivalent.

5.3.3 Detector—Electrolytic conductivity or microcoulometric detector. These types of detectors have proven effective in the analysis of wastewaters for the parameters listed in the scope (Section 1.1). The electrolytic conductivity detector was used to develop the method performance statements in Section 12. Guidelines for the use of alternate detectors are provided in Section 10.1.

5.4 Syringes—5-mL glass hypodermic with Luerlok tip (two each), if applicable to the purging device.

5.5 Micro syringes—25-μL, 0.006 in. ID needle.

5.6 Syringe valve—2-way, with Luer ends (three each).

5.7 Syringe—5-mL, gas-tight with shut-off valve.

5.8 Bottle—15-mL, screw-cap, with Teflon cap liner.

5.9 Balance—Analytical, capable of accurately weighing 0.0001 g.

6. Reagents

6.1 Reagent water—Reagent water is defined as a water in which an interferent is not observed at the MDL of the parameters of interest.

6.1.1 Reagent water can be generated by passing tap water through a carbon filter bed containing about 1 lb of activated carbon (Filtrisorb-300, Calgon Corp., or equivalent).

6.1.2 A water purification system (Millipore Super-Q or equivalent) may be used to generate reagent water.

6.1.3 Reagent water may also be prepared by boiling water for 15 min. Subsequently, while maintaining the temperature at 90 °C, bubble a contaminant-free inert gas through the water for 1 h. While still hot, transfer the water to a narrow mouth screw-cap bottle and seal with a Teflon-lined septum and cap.

6.2 Sodium thiosulfate—(ACS) Granular.

6.3 Trap Materials:

6.3.1 Coconut charcoal—6/10 mesh sieved to 26 mesh, Barnebey Cheney, CA-580-26 lot # M-2649 or equivalent.

6.3.2 2,6-Diphenylene oxide polymer—Tenax, (60/80 mesh), chromatographic grade or equivalent.

6.3.3 Methyl silicone packing—3% OV-1 on Chromosorb-W (60/80 mesh) or equivalent.

6.3.4 Silica gel—35/60 mesh, Davison, grade-15 or equivalent.

6.4 Methanol—Pesticide quality or equivalent.

6.5 Stock standard solutions—Stock standard solutions may be prepared from pure standard materials or purchased as certified solutions. Prepare stock standard solutions in methanol using assayed liquids or gases as appropriate. Because of the toxicity of some of the organohalides, primary dilutions of these materials should be prepared in a hood. A NIOSH/MESA approved toxic gas respirator should be used

when the analyst handles high concentrations of such materials.

6.5.1 Place about 9.8 mL of methanol into a 10-mL ground glass stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 min or until all alcohol wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

6.5.2 Add the assayed reference material:

6.5.2.1 Liquid—Using a 100 μL syringe, immediately add two or more drops of assayed reference material to the flask, then reweigh. Be sure that the drops fall directly into the alcohol without contacting the neck of the flask.

6.5.2.2 Gases—To prepare standards for any of the six halocarbons that boil below 30 °C (bromomethane, chloroethane, chloromethane, dichlorodifluoromethane, trichlorofluoromethane, vinyl chloride), fill a 5-mL valved gas-tight syringe with the reference standard to the 5.0-mL mark. Lower the needle to 5 mm above the methanol meniscus. Slowly introduce the reference standard above the surface of the liquid (the heavy gas will rapidly dissolve into the methanol).

6.5.3 Reweigh, dilute to volume, stopper, then mix by inverting the flask several times. Calculate the concentration in μg/μL from the net gain in weight. When compound purity is assayed to be 96% or greater, the weight can be used without correction to calculate the concentration of the stock standard. Commercially prepared stock standards can be used at any concentration if they are certified by the manufacturer or by an independent source.

6.5.4 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store, with minimal headspace, at -10 to -20 °C and protect from light.

6.5.5 Prepare fresh standards weekly for the six gases and 2-chloroethylvinyl ether. All other standards must be replaced after one month, or sooner if comparison with check standards indicates a problem.

6.6 Secondary dilution standards—Using stock standard solutions, prepare secondary dilution standards in methanol that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the aqueous calibration standards prepared in Sections 7.3.1 or 7.4.1 will bracket the working range of the analytical system. Secondary dilution standards should be stored with minimal headspace and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

6.7 Quality control check sample concentrate—See Section 8.2.1.

7. Calibration

7.1 Assemble a purge and trap system that meets the specifications in Section 5.2. Condition the trap overnight at 180 °C by backflushing with an inert gas flow of at least 20 mL/min. Condition the trap for 10 min once daily prior to use.

7.2 Connect the purge and trap system to a gas chromatograph. The gas chromatograph must be operated using temperature and flow

rate conditions equivalent to those given in Table 1. Calibrate the purge and trap-gas chromatographic system using either the external standard technique (Section 7.3) or the internal standard technique (Section 7.4).

7.3 External standard calibration procedure:

7.3.1 Prepare calibration standards at a minimum of three concentration levels for each parameter by carefully adding 20.0 μ L of one or more secondary dilution standards to 100, 500, or 1000 mL of reagent water. A 25- μ L syringe with a 0.006 in. ID needle should be used for this operation. One of the external standards should be at a concentration near, but above, the MDL (Table 1) and the other concentrations should correspond to the expected range of concentrations found in real samples or should define the working range of the detector. These aqueous standards can be stored up to 24 h, if held in sealed vials with zero headspace as described in Section 9.2. If not so stored, they must be discarded after 1 h.

7.3.2 Analyze each calibration standard according to Section 10, and tabulate peak height or area responses versus the concentration in the standard. The results can be used to prepare a calibration curve for each compound. Alternatively, if the ratio of response to concentration (calibration factor) is a constant over the working range (<10% relative standard deviation, RSD), linearity through the origin can be assumed and the average ratio or calibration factor can be used in place of a calibration curve.

7.4 Internal standard calibration procedure—To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples. The compounds recommended for use as surrogate spikes in Section 8.7 have been used successfully as internal standards, because of their generally unique retention times.

7.4.1 Prepare calibration standards at a minimum of three concentration levels for each parameter of interest as described in Section 7.3.1.

7.4.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Sections 6.5 and 6.6. It is recommended that the secondary dilution standard be prepared at a concentration of 15 μ g/mL of each internal standard compound. The addition of 10 μ L of this standard to 5.0 mL of sample or calibration standard would be equivalent to 30 μ g/L.

7.4.3 Analyze each calibration standard according to Section 10, adding 10 μ L of internal standard spiking solution directly to the syringe (Section 10.4). Tabulate peak height or area responses against concentration for each compound and internal standard, and calculate response factors (RF) for each compound using Equation 1.

Equation 1.

$$RF = \frac{(A_s)(C_u)}{(A_u)(C_s)}$$

where:

A_s = Response for the parameter to be measured.

A_u = Response for the internal standard.

C_u = Concentration of the internal standard.

C_s = Concentration of the parameter to be measured.

If the RF value over the working range is a constant (<10% RSD), the RF can be assumed to be invariant and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_u , vs. RF.

7.5 The working calibration curve, calibration factor, or RF must be verified on each working day by the measurement of a QC check sample.

7.5.1 Prepare the QC check sample as described in Section 8.2.2.

7.5.2 Analyze the QC check sample according to Section 10.

7.5.3 For each parameter, compare the response (Q) with the corresponding calibration acceptance criteria found in Table 2. If the responses for all parameters of interest fall within the designated ranges, analysis of actual samples can begin. If any individual Q falls outside the range, proceed according to Section 7.5.4.

Note: The large number of parameters in Table 2 present a substantial probability that one or more will not meet the calibration acceptance criteria when all parameters are analyzed.

7.5.4 Repeat the test only for those parameters that failed to meet the calibration acceptance criteria. If the response for a parameter does not fall within the range in this second test, a new calibration curve, calibration factor, or RF must be prepared for that parameter according to Section 7.3 or 7.4.

8. Quality Control

8.1 Each laboratory that uses this method is required to operate a formal quality control program. The minimum requirements of this program consist of an initial demonstration of laboratory capability and an ongoing analysis of spiked samples to evaluate and document data quality. The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results of sample spikes indicate atypical method performance, a quality control check standard must be analyzed to confirm that the measurements were performed in an in-control mode of operation.

8.1.1 The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. This ability is established as described in Section 8.2.

8.1.2 In recognition of advances that are occurring in chromatography, the analyst is permitted certain options (detailed in Section 10.1) to improve the separations or lower the cost of measurements. Each time such a

modification is made to the method, the analyst is required to repeat the procedure in Section 8.2.

8.1.3 Each day, the analyst must analyze a reagent water blank to demonstrate that interferences from the analytical system are under control.

8.1.4 The laboratory must, on an ongoing basis, spike and analyze a minimum of 10% of all samples to monitor and evaluate laboratory data quality. This procedure is described in Section 8.3.

8.1.5 The laboratory must, on an ongoing basis, demonstrate through the analyses of quality control check standards that the operation of the measurement system is in control. This procedure is described in Section 8.4. The frequency of the check standard analyses is equivalent to 10% of all samples analyzed but may be reduced if spike recoveries from samples (Section 8.3) meet all specified quality control criteria.

8.1.6 The laboratory must maintain performance records to document the quality of data that is generated. This procedure is described in Section 8.5.

8.2 To establish the ability to generate acceptable accuracy and precision, the analyst must perform the following operations.

8.2.1 A quality control (QC) check sample concentrate is required containing each parameter of interest at a concentration of 10 μ g/mL in methanol. The QC check sample concentrate must be obtained from the U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory in Cincinnati, Ohio, if available. If not available from that source, the QC check sample concentrate must be obtained from another external source. If not available from either source above, the QC check sample concentrate must be prepared by the laboratory using stock standards prepared independently from those used for calibration.

8.2.2 Prepare a QC check sample to contain 20 μ g/L of each parameter by adding 200 μ L of QC check sample concentrate to 100 mL of reagent water.

8.2.3 Analyze four 5-mL aliquots of the well-mixed QC check sample according to Section 10.

8.2.4 Calculate the average recovery (\bar{X}) in μ g/L, and the standard deviation of the recovery (s) in μ g/L for each parameter of interest using the four results.

8.2.5 For each parameter compare s and \bar{X} with the corresponding acceptance criteria for precision and accuracy, respectively, found in Table 2. If s and \bar{X} for all parameters of interest meet the acceptance criteria, the system performance is acceptable and analysis of actual samples can begin. If any individual s exceeds the precision limit or any individual \bar{X} falls outside the range for accuracy, then the system performance is unacceptable for that parameter.

Note: The large number of parameters in Table 2 present a substantial probability that one or more will fail at least one of the acceptance criteria when all parameters are analyzed.

8.2.6 When one or more of the parameters tested fail at least one of the acceptance

criteria, the analyst must proceed according to Section 8.2.8.1 or 8.2.8.2.

8.2.8.1 Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with Section 8.2.3.

8.2.8.2 Beginning with Section 8.2.3, repeat the test only for those parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with Section 8.2.3.

8.3 The laboratory must on an ongoing basis, spike at least 10% of the samples from each sample site being monitored to assess accuracy. For laboratories analyzing one to ten samples per month, at least one spiked sample per month is required.

8.3.1 The concentration of the spike in the sample should be determined as follows:

8.3.1.1 If, as in compliance monitoring, the concentration of a specific parameter in the sample is being checked against a regulatory concentration limit, the spike should be at that limit or 1 to 5 times higher than the background concentration determined in Section 8.3.2, whichever concentration would be larger.

8.3.1.2 If the concentration of a specific parameter in the sample is not being checked against a limit specific to that parameter, the spike should be at 20 µg/L or 1 to 5 times higher than the background concentration determined in Section 8.3.2, whichever concentration would be larger.

8.3.2 Analyze one 5-mL sample aliquot to determine the background concentration (B) of each parameter. If necessary, prepare a new QC check sample concentrate (Section 8.2.1) appropriate for the background concentrations in the sample. Spike a second 5-mL sample aliquot with 10 µL of the QC check sample concentrate and analyze it to determine the concentration after spiking (A) of each parameter. Calculate each percent recovery (P) as $100(A-B)/T$, where T is the known true value of the spike.

8.3.3 Compare the percent recovery (P) for each parameter with the corresponding QC acceptance criteria found in Table 2. These acceptance criteria were calculated to include an allowance for error in measurement of both the background and spike concentrations, assuming a spike to background ratio of 5:1. This error will be accounted for to the extent that the analyst's spike to background ratio approaches 5:1. If spiking was performed at a concentration lower than 20 µg/L, the analyst must use either the QC acceptance criteria in Table 2, or optional QC acceptance criteria calculated for the specific spike concentration. To calculate optional acceptance criteria for the recovery of a parameter: (1) Calculate accuracy (X') using the equation in Table 3, substituting the spike concentration (T) for C; (2) calculate overall precision (S') using the equation in Table 3, substituting X' for X; (3) calculate the range for recovery at the spike concentration as $100 X'/T \pm 2.44(100 S'/T)\%$.

8.3.4 If any individual P falls outside the designated range for recovery, that parameter has failed the acceptance criteria. A check

standard containing each parameter that failed the criteria must be analyzed as described in Section 8.4.

8.4 If any parameter fails the acceptance criteria for recovery in Section 8.3, a QC check standard containing each parameter that failed must be prepared and analyzed.

Note: The frequency for the required analysis of a QC check standard will depend upon the number of parameters being simultaneously tested, the complexity of the sample matrix, and the performance of the laboratory. If the entire list of parameters in Table 2 must be measured in the sample in Section 8.3, the probability that the analysis of a QC check standard will be required is high. In this case the QC check standard should be routinely analyzed with the spiked sample.

8.4.1 Prepare the QC check standard by adding 10 µL of QC check sample concentrate (Sections 8.2.1 or 8.3.2) to 5 mL of reagent water. The QC check standard needs only to contain the parameters that failed criteria in the test in Section 8.3.

8.4.2 Analyze the QC check standard to determine the concentration measured (A) of each parameter. Calculate each percent recovery (P_c) as $100(A/T)\%$, where T is the true value of the standard concentration.

8.4.3 Compare the percent recovery (P_c) for each parameter with the corresponding QC acceptance criteria found in Table 2. Only parameters that failed the test in Section 8.3 need to be compared with these criteria. If the recovery of any such parameter falls outside the designated range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the unspiked sample is suspect and may not be reported for regulatory compliance purposes.

8.5 As part of the QC program for the laboratory, method accuracy for wastewater samples must be assessed and records must be maintained. After the analysis of five spiked wastewater samples as in Section 8.3, calculate the average percent recovery (\bar{P}) and the standard deviation of the percent recovery (s_p). Express the accuracy assessment as a percent recovery interval from $\bar{P} - 2s_p$ to $\bar{P} + 2s_p$. If $\bar{p} = 90\%$ and $s_p = 10\%$, for example, the accuracy interval is expressed as 70–110%. Update the accuracy assessment for each parameter on a regular basis (e.g. after each five to ten new accuracy measurements).

8.6 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory and the nature of the samples. Field duplicates may be analyzed to assess the precision of the environmental measurements. When doubt exists over the identification of a peak on the chromatogram, confirmatory techniques such as gas chromatography with a dissimilar column, specific element detector, or mass spectrometer must be used. Whenever possible, the laboratory should analyze standard reference materials and participate in relevant performance evaluation studies.

8.7 The analyst should monitor both the performance of the analytical system and the

effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent water blank with surrogate halocarbons. A combination of bromochloromethane, 2-bromo-1-chloropropane, and 1,4-dichlorobutane is recommended to encompass the range of the temperature program used in this method. From stock standard solutions prepared as in Section 6.5, add a volume to give 750 µg of each surrogate to 45 mL of reagent water contained in a 50-mL volumetric flask, mix and dilute to volume for a concentration of 15 ng/µL. Add 10 µL of this surrogate spiking solution directly into the 5-mL syringe with every sample and reference standard analyzed. Prepare a fresh surrogate spiking solution on a weekly basis. If the internal standard calibration procedure is being used, the surrogate compounds may be added directly to the internal standard spiking solution (Section 7.4.2).

9. Sample Collection, Preservation, and Handling

9.1 All samples must be iced or refrigerated from the time of collection until analysis. If the sample contains free or combined chlorine, add sodium thiosulfate preservative (10 mg/40 mL is sufficient for up to 5 ppm Cl₂) to the empty sample bottle just prior to shipping to the sampling site. EPA Methods 330.4 and 330.5 may be used for measurement of residual chlorine. Field test kits are available for this purpose.

9.2 Grab samples must be collected in glass containers having a total volume of at least 25 mL. Fill the sample bottle just to overflowing in such a manner that no air bubbles pass through the sample as the bottle is being filled. Seal the bottle so that no air bubbles are entrapped in it. If preservative has been added, shake vigorously for 1 min. Maintain the hermetic seal on the sample bottle until time of analysis.

9.3 All samples must be analyzed within 14 days of collection.

10. Procedure

10.1 Table 1 summarizes the recommended operating conditions for the gas chromatograph. Included in this table are estimated retention times and MDL that can be achieved under these conditions. An example of the separations achieved by Column 1 is shown in Figure 5. Other packed columns, chromatographic conditions, or detectors may be used if the requirements of Section 8.2 are met.

10.2 Calibrate the system daily as described in Section 7.

10.3 Adjust the purge gas (nitrogen or helium) flow rate to 40 mL/min. Attach the trap inlet to the purging device, and set the purge and trap system to purge (Figure 3). Open the syringe valve located on the purging device sample introduction needle.

10.4 Allow the sample to come to ambient temperature prior to introducing it to the syringe. Remove the plunger from a 5-mL syringe and attach a closed syringe valve. Open the sample bottle (or standard) and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve and vent any residual

air while adjusting the sample volume to 5.0 mL. Since this process of taking an aliquot destroys the validity of the sample for future analysis, the analyst should fill a second syringe at this time to protect against possible loss of data. Add 10.0 µL of the surrogate spiking solution (Section 8.7) and 10.0 µL of the internal standard spiking solution (Section 7.4.2), if applicable, through the valve bore, then close the valve.

10.5 Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valves and inject the sample into the purging chamber.

10.6 Close both valves and purge the sample for 11.0 ± 0.1 min at ambient temperature.

10.7 After the 11-min purge time, attach the trap to the chromatograph, adjust the purge and trap system to the desorb mode (Figure 4), and begin to temperature program the gas chromatograph. Introduce the trapped materials to the GC column by rapidly heating the trap to 180 °C while backflushing the trap with an inert gas between 20 and 60 mL/min for 4 min. If rapid heating of the trap cannot be achieved, the GC column must be used as a secondary trap by cooling it to 30 °C (subambient temperature, if poor peak geometry or random retention time problems persist) instead of the initial program temperature of 45 °C.

10.8 While the trap is being desorbed into the gas chromatograph, empty the purging chamber using the sample introduction syringe. Wash the chamber with two 5-mL flushes of reagent water.

10.9 After desorbing the sample for 4 min, recondition the trap by returning the purge and trap system to the purge mode. Wait 15 s then close the syringe valve on the purging device to begin gas flow through the trap. The trap temperature should be maintained at 180 °C. After approximately 7 min, turn off the trap heater and open the syringe valve to stop the gas flow through the trap. When the trap is cool, the next sample can be analyzed.

10.10 Identify the parameters in the sample by comparing the retention times of the peaks in the sample chromatogram with those of the peaks in standard chromatograms. The width of the retention time window used to make identifications should be based upon measurements of actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time for a compound can be used to calculate a suggested window size; however, the experience of the analyst should weigh heavily in the interpretation of chromatograms.

10.11 If the response for a peak exceeds the working range of the system, prepare a dilution of the sample with reagent water from the aliquot in the second syringe and reanalyze.

11. Calculations

11.1 Determine the concentration of individual compounds in the sample.

11.1.1 If the external standard calibration procedure is used, calculate the concentration of the parameter being measured from the peak response using the calibration curve or calibration factor determined in Section 7.3.2.

11.1.2 If the internal standard calibration procedure is used, calculate the concentration in the sample using the response factor (RF) determined in Section 7.4.3 and Equation 2.

$$\text{Concentration } (\mu\text{g/L}) = \frac{(A_s)(C_{is})}{(A_{is})(\text{RF})}$$

where:

A_s = Response for the parameter to be measured.

A_{is} = Response for the internal standard.

C_{is} = Concentration of the internal standard.

11.2 Report results in µg/L without correction for recovery data. All QC data obtained should be reported with the sample results.

12. Method Performance

12.1 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero.¹ The MDL concentrations listed in Table 1 were obtained using reagent water.² Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

12.2 This method is recommended for use in the concentration range from the MDL to $1000 \times \text{MDL}$. Direct aqueous injection techniques should be used to measure concentration levels above $1000 \times \text{MDL}$.

12.3 This method was tested by 20 laboratories using reagent water, drinking water, surface water, and three industrial wastewaters spiked at six concentrations over the range 8.0 to 500 µg/L.³ Single

operator precision, overall precision, and method accuracy were found to be directly related to the concentration of the parameter and essentially independent of the sample matrix. Linear equations to describe these relationships are presented in Table 3.

References

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- "EPA Method Validation Study: 23. Method 601 (Purgeable Halocarbons)." Report for EPA Contract 68-03-2856 (in preparation).
- "Method Validation Data for EPA Method 601." Memorandum from J. Potter, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268, November 10, 1983.

TABLE 1.—CHROMATOGRAPHIC CONDITIONS AND METHOD DETECTION LIMITS

Parameter	Retention time (min)		Method detection limit (µg/L)
	Column 1	Column 2	
Chloromethane	1.50	5.28	0.06
Bromomethane	2.17	7.05	1.16
Dichlorodifluoromethane	2.62	nd	1.81
Vinyl chloride	2.67	5.28	0.18
Chloroethane	3.33	8.68	0.52
Methylene chloride	5.25	10.1	0.25
Trichlorofluoromethane	7.18	nd	nd
1,1-Dichloroethane	7.93	7.72	0.13
1,1-Dichloroethane	9.30	12.6	0.07
trans-1,2-Dichloroethane	10.1	2.36	0.10

TABLE 1.—CHROMATOGRAPHIC CONDITIONS AND METHOD DETECTION LIMITS—Continued

Parameter	Retention time (min)		Method detection limit (µg/L)
	Column 1	Column 2	
Chloroform	10.7	12.1	0.05
1,2-Dichloroethane	11.4	15.4	0.03
1,1,1-Trichloroethane	12.6	13.1	0.03
Carbon tetrachloride	13.0	14.4	0.12
Bromodichloromethane	13.7	14.6	0.10
1,2-Dichloropropane	14.9	16.6	0.04
cis-1,3-Dichloropropene	15.2	16.6	0.34
Trichloroethene	15.8	13.1	0.12
Dibromochloromethane	16.5	16.6	0.09
1,1,2-Trichloroethane	16.5	16.1	0.02
trans-1,3-Dichloropropene	16.5	18.0	0.20
2-Chloroethylnyl ether	18.0	nd	0.13
Bromoform	19.2	19.2	0.20
1,1,2,2-Tetrachloroethane	21.6	nd	0.03
Tetrachloroethene	21.7	15.0	0.03
Chlorobenzene	24.2	16.8	0.25
1,3-Dichlorobenzene	34.0	22.4	0.32
1,2-Dichlorobenzene	34.9	23.9	0.15
1,4-Dichlorobenzene	35.4	22.3	0.24

Column 1 conditions: Carboapak B (60/80 mesh) coated with 1% SP-1000 packed in an 8 ft x 0.1 in. ID stainless steel or glass column with helium carrier gas at 40 mL/min flow rate. Column temperature held at 45 °C for 3 min then programmed at 8 °C/min to 220 °C and held for 15 min.

Column 2 conditions: Porasil-Q (100/120 mesh) coated with n-octane packed in a 6 ft x 0.1 in. ID stainless steel or glass column with helium carrier gas at 40 mL/min flow rate. Column temperature held at 50 °C for 3 min then programmed at 8 °C/min to 170 °C and held for 4 min.

nd = not determined.

TABLE 2.—CALIBRATION AND QC ACCEPTANCE CRITERIA—METHOD 601 *

Parameter	Range for Q (µg/L)	Limit for s (µg/L)	Range for \bar{x} (µg/L)	Range P P _i (%)
Bromodichloromethane	15.2-24.6	4.3	10.7-32.0	42-172
Bromoform	14.7-25.3	4.7	5.0-29.3	13-159
Bromomethane	11.7-28.3	7.6	3.4-24.5	D-144
Carbon tetrachloride	13.7-26.3	5.6	11.8-25.3	43-143
Chlorobenzene	14.4-25.6	5.0	10.2-27.4	38-150
Chloroethane	15.4-24.6	4.4	11.3-25.2	46-137
2-Chloroethylnyl ether	12-28.0	8.3	4.5-35.5	14-186
Chloroform	15-25.0	4.5	12.4-24.0	49-133
Chloromethane	11.9-28.1	7.4	D-34.9	D-183
Dibromochloromethane	13.1-26.9	6.3	7.9-35.1	24-191
1,2-Dichlorobenzene	14.0-26.0	5.5	1.7-38.9	D-208
1,3-Dichlorobenzene	9.9-30.1	9.1	6.2-32.6	7-167
1,4-Dichlorobenzene	13.9-26.1	5.5	11.5-25.5	42-143
1,1-Dichloroethane	16.8-23.2	3.2	11.2-24.6	47-132
1,2-Dichloroethane	14.3-25.7	5.2	13.0-26.5	51-147
1,1-Dichloroethene	12.6-27.4	6.6	10.2-27.3	28-167
trans-1,2-Dichloroethane	12.8-27.2	6.4	11.4-27.1	38-155
1,2-Dichloropropene	14.8-25.2	5.2	10.1-29.9	44-156
cis-1,3-Dichloropropene	12.8-27.2	7.3	6.2-33.8	22-178
trans-1,3-Dichloropropene	12.8-27.2	7.3	6.2-33.8	22-178
Methylene chloride	15.5-24.5	4.0	7.0-27.6	25-162
1,1,2,2-Tetrachloroethane	9.8-30.2	9.2	6.6-31.8	6-184
Tetrachloroethene	14.0-26.0	5.4	8.1-29.6	26-162
1,1,1-Trichloroethane	14.2-25.8	4.9	10.8-24.8	41-138
1,1,2-Trichloroethane	15.7-24.3	3.9	9.6-25.4	39-136
Trichloroethene	15.4-24.6	4.2	9.2-26.6	35-146
Trichlorofluoromethane	13.3-26.7	6.0	7.4-28.1	21-156
Vinyl chloride	13.7-26.3	5.7	8.2-29.9	26-163

Q = Concentration measured in QC check sample, in µg/L (Section 7.5.3).

s = Standard deviation of four recovery measurements, in µg/L (Section 8.2.4).

\bar{x} = Average recovery for four recovery measurements, in µg/L (Section 8.2.4).

P, P_i = Percent recovery measured (Section 8.3.2, Section 8.4.2).

D = Detected; result must be greater than zero.

* Criteria were calculated assuming a QC check sample concentration of 20 µg/L.

Note: These criteria are based directly upon the method performance data in Table

3. Where necessary, the limits for recovery have been broadened to assure applicability

of the limits to concentrations below those used to develop Table 3.

TABLE 3.—METHOD ACCURACY AND PRECISION AS FUNCTIONS OF CONCENTRATION—METHOD 601

Parameter	Accuracy, as recovery, \bar{x} (µg/L)	Single analyst precision, s, (µg/L)	Overall precision, S, (µg/L)
Bromodichloromethane	1.12C-1.02	0.11 \bar{x} +0.04	0.20 \bar{x} +1.00
Bromoform	0.96C-2.05	0.12 \bar{x} +0.58	0.21 \bar{x} +2.41
Bromomethane	0.76C-1.27	0.26 \bar{x} +0.27	0.36 \bar{x} +0.94
Carbon tetrachloride	0.98C-1.04	0.15 \bar{x} +0.38	0.20 \bar{x} +0.39
Chlorobenzene	1.00C-1.23	0.15 \bar{x} -0.02	0.18 \bar{x} +1.21
Chloroethane	0.99C-1.53	0.14 \bar{x} -0.13	0.17 \bar{x} +0.63
2-Chloroethylnyl ether *	1.00C	0.20 \bar{x}	0.35 \bar{x}
Chloroform	0.93C-0.39	0.13 \bar{x} +0.15	0.19 \bar{x} -0.02
Chloromethane	0.77C+0.18	0.26 \bar{x} -0.31	0.52 \bar{x} +1.31
Dibromochloromethane	0.94C+2.72	0.11 \bar{x} +1.10	0.24 \bar{x} +1.68
1,2-Dichlorobenzene	0.93C+1.70	0.20 \bar{x} +0.97	0.13 \bar{x} +6.13

TABLE 3.—METHOD ACCURACY AND PRECISION AS FUNCTIONS OF CONCENTRATION—METHOD 601—Continued

Parameter	Accuracy, as recovery, \bar{X} ($\mu\text{g/L}$)	Single analyst precision, s_x ($\mu\text{g/L}$)	Overall precision, S ($\mu\text{g/L}$)
1,3-Dichlorobenzene	$0.95C + 0.43$	$0.14\bar{X} + 2.33$	$0.26\bar{X} + 2.34$
1,4-Dichlorobenzene	$0.93C - 0.09$	$0.15\bar{X} + 0.29$	$0.20\bar{X} + 0.41$
1,1-Dichloroethane	$0.95C - 1.08$	$0.08\bar{X} + 0.17$	$0.14\bar{X} + 0.94$
1,2-Dichloroethane	$1.04C - 1.08$	$0.11\bar{X} + 0.70$	$0.15\bar{X} + 0.94$
1,1-Dichloroethene	$0.98C - 0.67$	$0.21\bar{X} - 0.23$	$0.29\bar{X} - 0.40$
trans-1,2-Dichloroethene	$0.97C - 0.16$	$0.11\bar{X} + 1.46$	$0.17\bar{X} + 1.46$
1,2-Dichloropropene	$1.00C$	$0.13\bar{X}$	$0.23\bar{X}$
cis-1,3-Dichloropropene *	$1.00C$	$0.16\bar{X}$	$0.32\bar{X}$
trans-1,3-Dichloropropene *	$1.00C$	$0.16\bar{X}$	$0.32\bar{X}$
Methylene chloride	$0.91C - 0.93$	$0.11\bar{X} + 0.33$	$0.21\bar{X} + 1.43$
1,1,2,2-Tetrachloroethene	$0.95C + 0.19$	$0.14\bar{X} + 2.41$	$0.23\bar{X} + 2.79$
Tetrachloroethene	$0.94C + 0.06$	$0.14\bar{X} + 0.38$	$0.18\bar{X} + 2.21$
1,1,1-Trichloroethane	$0.90C - 0.16$	$0.15\bar{X} + 0.04$	$0.20\bar{X} + 0.37$
1,1,2-Trichloroethane	$0.86C + 0.30$	$0.13\bar{X} - 0.14$	$0.19\bar{X} - 0.67$
Trichloroethene	$0.87C + 0.48$	$0.13\bar{X} - 0.03$	$0.23\bar{X} - 0.30$
Trichlorofluoromethane	$0.89C - 0.07$	$0.15\bar{X} + 0.67$	$0.26\bar{X} - 0.91$
Vinyl chloride	$0.97C - 0.36$	$0.13\bar{X} + 0.66$	$0.27\bar{X} + 0.40$

\bar{X} = Expected recovery for one or more measurements of a sample containing a concentration of C , in $\mu\text{g/L}$.
 s_x = Expected single analyst standard deviation of measurements at an average concentration found of \bar{X} , in $\mu\text{g/L}$.
 S = Expected interlaboratory standard deviation of measurements at an average concentration found of \bar{X} , in $\mu\text{g/L}$.
 C = True value for the concentration, in $\mu\text{g/L}$.
 \bar{X} = Average recovery found for measurements of samples containing a concentration of C , in $\mu\text{g/L}$.
* Estimates based upon the performance in a single laboratory.¹⁰

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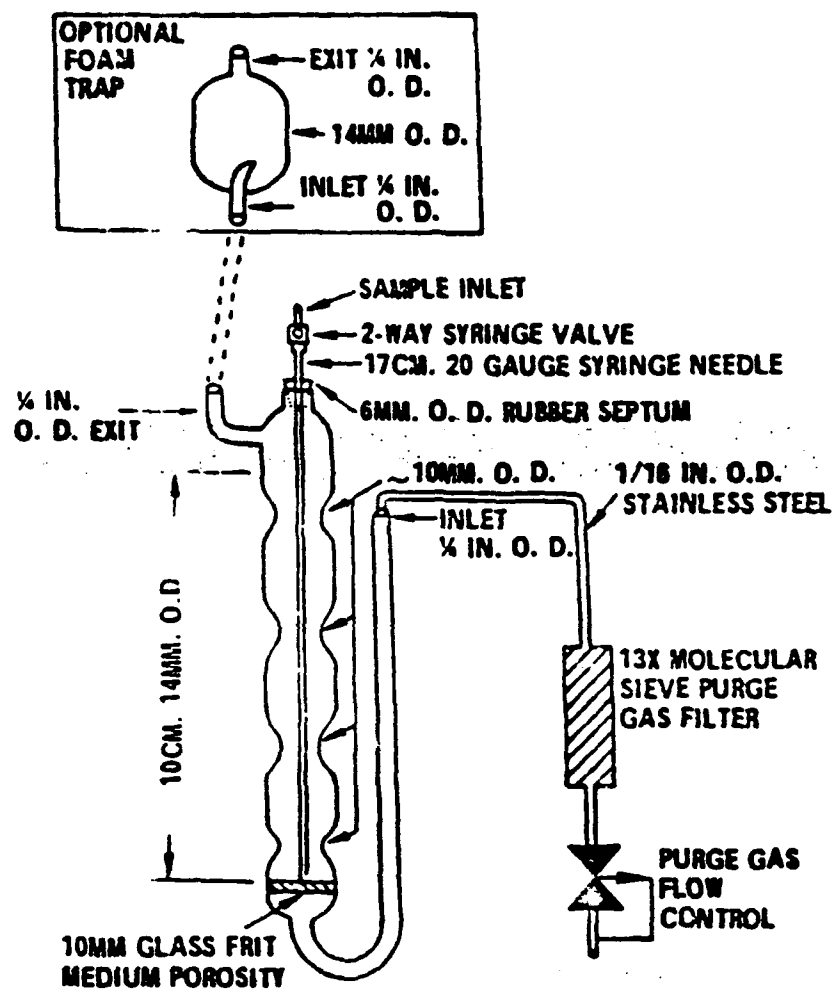


Figure 1. Purging device.

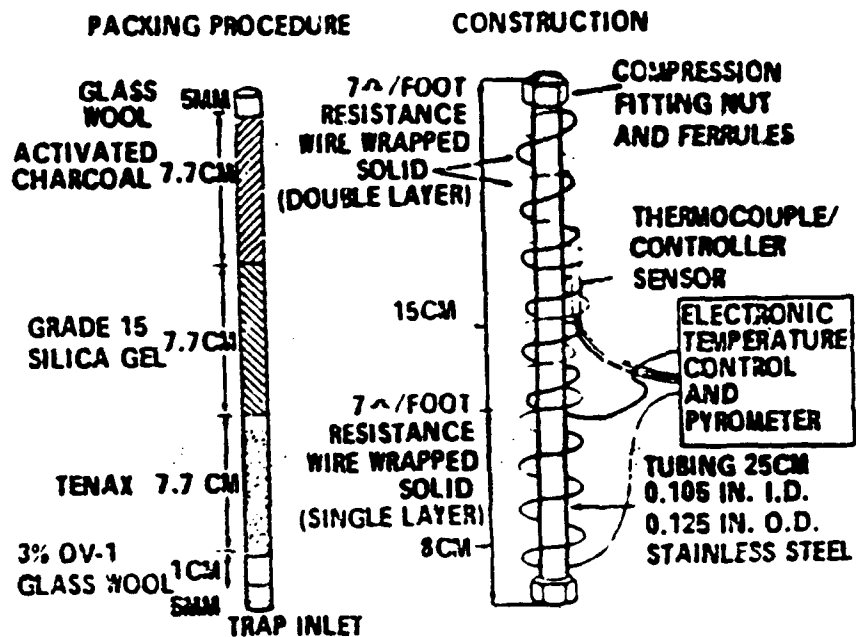


Figure 2. Trap packings and construction to include desorb capability

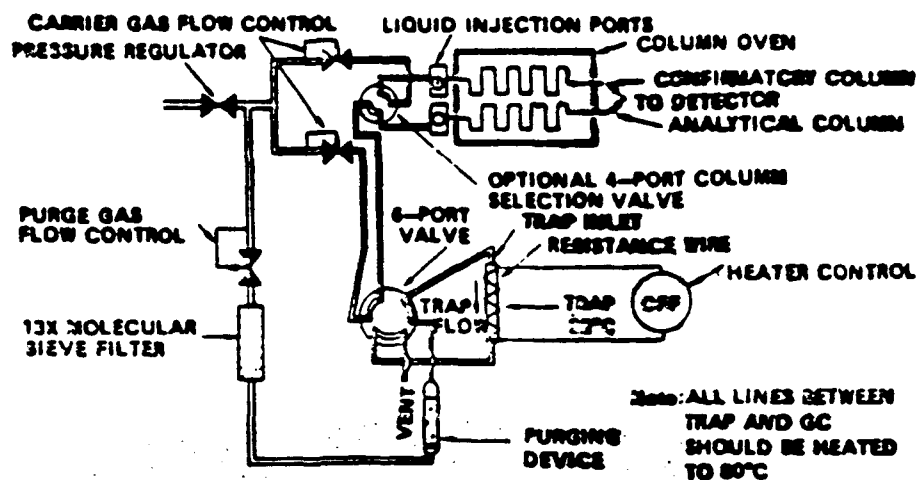


Figure 3. Purge and trap system-purge mode.

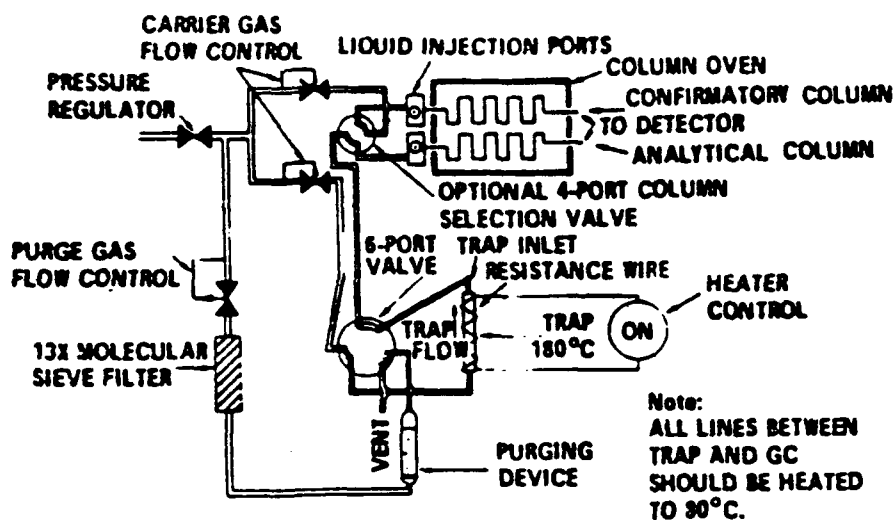


Figure 4. Purge and trap system - desorb mode.

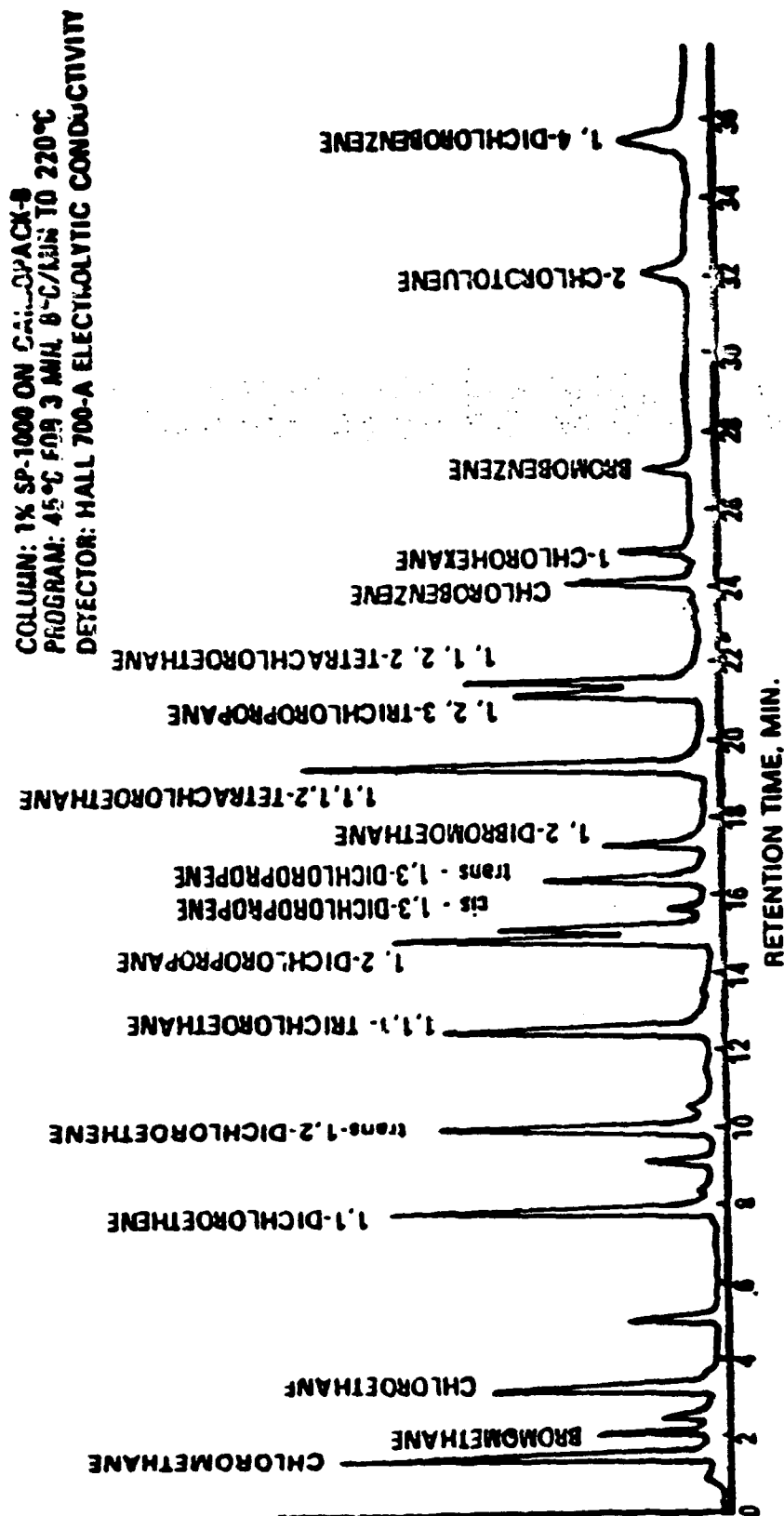


Figure 5. Gas chromatogram of purgeable halocarbons.

EPA-600/6-84-001

Method 602—Purgeable Aromatics

1. Scope and Application

1.1 This method covers the determination of various purgeable aromatics. The following parameters may be determined by this method:

Parameter	STORET No.	CAS No.
Benzene	34030	71-43-2
Chlorobenzene	34301	108-90-7
1,2-Dichlorobenzene	34536	95-50-1
1,3-Dichlorobenzene	34566	541-73-1
1,4-Dichlorobenzene	34571	106-46-7
Ethylbenzene	34371	100-41-4
Toluene	34010	108-38-3

1.2 This is a purge and trap gas chromatographic (GC) method applicable to the determination of the compounds listed above in municipal and industrial discharges as provided under 40 CFR 136.1. When this method is used to analyze unfamiliar samples for any or all of the compounds above, compound identifications should be supported by at least one additional qualitative technique. This method describes analytical conditions for a second gas chromatographic column that can be used to confirm measurements made with the primary column. Method 624 provides gas chromatograph/mass spectrometer (GC/MS) conditions appropriate for the qualitative and quantitative confirmation of results for all of the parameters listed above.

1.3 The method detection limit (MDL defined in Section 12.1) for each parameter is listed in Table 1. The MDL for a specific wastewater may differ from those listed, depending upon the nature of interferences in the sample matrix.

1.4 Any modification of this method, beyond those expressly permitted, shall be considered as a major modification subject to application and approval of alternate test procedures under 40 CFR 136.4 and 136.5.

1.5 This method is restricted to use by or under the supervision of analysts experienced in the operation of a purge and trap system and a gas chromatograph and in the interpretation of gas chromatograms. Each analyst must demonstrate the ability to generate acceptable results with this method using the procedure described in Section 8.2.

2. Summary of Method

2.1 An inert gas is bubbled through a 5-mL water sample contained in a specially-designed purging chamber at ambient temperature. The aromatics are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent trap where the aromatics are trapped. After purging is completed, the trap is heated and backflushed with the inert gas to desorb the aromatics onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate the aromatics which are then detected with a photoionization detector.

2.2 The method provides an optional gas chromatographic column that may be helpful in resolving the compounds of interest from interferences that may occur.

3. Interferences

3.1 Impurities in the purge gas and organic compounds outgassing from the plumbing ahead of the trap account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks as described in Section 8.1.3. The use of non-Teflon plastic tubing, non-Teflon thread sealants, or flow controllers with rubber components in the purge and trap system should be avoided.

3.2 Samples can be contaminated by diffusion of volatile organics through the septum seal into the sample during shipment and storage. A field reagent blank prepared from reagent water and carried through the sampling and handling protocol can serve as a check on such contamination.

3.3 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. To reduce carry-over, the purging device and sample syringe must be rinsed with reagent water between sample analyses. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high aromatic levels, it may be necessary to wash the purging device with a detergent solution, rinse it with distilled water, and then dry it in an oven at 105 °C between analyses. The trap and other parts of the system are also subject to contamination; therefore, frequent bakeout and purging of the entire system may be required.

4. Safety

4.1 The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical compound should be treated as a potential health hazard. From this viewpoint, exposure to these chemicals must be reduced to the lowest possible level by whatever means available. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of material data handling sheets should also be made available to all personnel involved in the chemical analysis. Additional references to laboratory safety are available and have been identified ** for the information of the analyst.

4.2 The following parameters covered by this method have been tentatively classified as known or suspected, human or mammalian carcinogens: benzene and 1,4-dichlorobenzene. Primary standards of these toxic compounds should be prepared in a hood. A NIOSH/MESA approved toxic gas respirator should be worn when the analyst handles high concentrations of these toxic compounds.

5. Apparatus and Materials

5.1 Sampling equipment, for discrete sampling.

5.1.1 Vial—25-mL capacity or larger, equipped with a screw cap with a hole in the

center (Pierce #13075 or equivalent). Detergent wash, rinse with tap and distilled water, and dry at 105 °C before use.

5.1.2 Septum—Teflon-faced silicone (Pierce #12722 or equivalent). Detergent wash, rinse with tap and distilled water, and dry at 105 °C for 1 h before use.

5.2 Purge and trap system—The purge and trap system consists of three separate pieces of equipment: A purging device, trap, and desorber. Several complete systems are now commercially available.

5.2.1 The purging device must be designed to accept 5-mL samples with a water column at least 3 cm deep. The gaseous head space between the water column and the trap must have a total volume of less than 15 mL. The purge gas must pass through the water column as finely divided bubbles with a diameter of less than 3 mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. The purging device illustrated in Figure 1 meets these design criteria.

5.2.2 The trap must be at least 25 cm long and have an inside diameter of at least 0.105 in.

5.2.2.1 The trap is packed with 1 cm of methyl silicone coated packing (Section 6.4.2) and 23 cm of 2,6-diphenylene oxide polymer (Section 6.4.1) as shown in Figure 2. This trap was used to develop the method performance statements in Section 12.

5.2.2.2 Alternatively, either of the two traps described in Method 601 may be used, although water vapor will preclude the measurement of low concentrations of benzene.

5.2.3 The desorber must be capable of rapidly heating the trap to 180 °C. The polymer section of the trap should not be heated higher than 180 °C and the remaining sections should not exceed 200 °C. The desorber illustrated in Figure 2 meets these design criteria.

5.2.4 The purge and trap system may be assembled as a separate unit or be coupled to a gas chromatograph as illustrated in Figures 3, 4, and 5.

5.3 Gas chromatograph—An analytical system complete with a temperature programmable gas chromatograph suitable for on-column injection and all required accessories including syringes, analytical columns, gases, detector, and strip-chart recorder. A data system is recommended for measuring peak areas.

5.3.1 Column 1—6 ft long x 0.082 in. ID stainless steel or glass, packed with 5% SP-1200 and 1.75% Bentone-34 on Supelcoport (100/120 mesh) or equivalent. This column was used to develop the method performance statements in Section 12. Guidelines for the use of alternate column packings are provided in Section 10.1.

5.3.2 Column 2—8 ft long x 0.1 in ID stainless steel or glass, packed with 5% 1,2,3-Tris(2-cyanoethoxy)propane on Chromosorb W-AW (60/80 mesh) or equivalent.

5.3.3 Detector—Photoionization detector (h-Nu Systems, Inc. Model PI-51-02 or equivalent). This type of detector has been proven effective in the analysis of wastewaters for the parameters listed in the scope (Section 1.1), and was used to develop

the method performance statements in Section 12. Guidelines for the use of alternate detectors are provided in Section 10.1.

5.4 Syringes—5-mL glass hypodermic with Luerlok tip (two each), if applicable to the purging device.

5.5 Micro syringes—25- μ L, 0.006 in. ID needle.

5.6 Syringe valve—2-way, with Luer ends (three each).

5.7 Bottle—15-mL, screw-cap, with Teflon cap liner.

5.8 Balance—Analytical, capable of accurately weighing 0.0001 g.

8. Reagents

6.1 Reagent water—Reagent water is defined as a water in which an interferent is not observed at the MDL of the parameters of interest.

6.1.1 Reagent water can be generated by passing tap water through a carbon filter bed containing about 1 lb of activated carbon (Filtrisorb-300, Calgon Corp., or equivalent).

6.1.2 A water purification system (Millipore Super-Q or equivalent) may be used to generate reagent water.

6.1.3 Reagent water may also be prepared by boiling water for 15 min. Subsequently, while maintaining the temperature at 90 °C, bubble a contaminant-free inert gas through the water for 1 h. While still hot, transfer the water to a narrow mouth screw-cap bottle and seal with a Teflon-lined septum and cap.

6.2 Sodium thiosulfate—(ACS) Granular.

6.3 Hydrochloric acid (1+1)—Add 50 mL of concentrated HCl (ACS) to 50 mL of reagent water.

6.4 Trap Materials:

6.4.1 2,6-Diphenylene oxide polymer—Tenax, (60/80 mesh), chromatographic grade or equivalent.

6.4.2 Methyl silicone packing—3% OV-1 on Chromosorb-W (60/80 mesh) or equivalent.

6.5 Methanol—Pesticide quality or equivalent.

6.6 Stock standard solutions—Stock standard solutions may be prepared from pure standard materials or purchased as certified solutions. Prepare stock standard solutions in methanol using assayed liquids. Because of the toxicity of benzene and 1,4-dichlorobenzene, primary dilutions of these materials should be prepared in a hood. A NIOSH/MESA approved toxic gas respirator should be used when the analyst handles high concentrations of such materials.

6.6.1 Place about 9.8 mL of methanol into a 10-mL ground glass stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 min or until all alcohol wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

6.6.2 Using a 100- μ L syringe, immediately add two or more drops of assayed reference material to the flask, then reweigh. Be sure that the drops fall directly into the alcohol without contacting the neck of the flask.

6.6.3 Reweigh, dilute to volume, stopper, then mix by inverting the flask several times. Calculate the concentration in μ g/ μ L from the net gain in weight. When compound purity is assayed to be 98% or greater, the weight can be used without correction to calculate the concentration of the stock

standard. Commercially prepared stock standards can be used at any concentration if they are certified by the manufacturer or by an independent source.

6.6.4 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store at 4 °C and protect from light.

6.6.5 All standards must be replaced after one month, or sooner if comparison with check standards indicates a problem.

6.7 Secondary dilution standards—Using stock standard solutions, prepare secondary dilution standards in methanol that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the aqueous calibration standards prepared in Sections 7.3.1 or 7.4.1 will bracket the working range of the analytical system. Secondary solution standards must be stored with zero headspace and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

6.8 Quality control check sample concentrate—See Section 8.2.1.

7. Calibration

7.1 Assemble a purge and trap system that meets the specifications in Section 5.2. Condition the trap overnight at 180 °C by backflushing with an inert gas flow of at least 20 mL/min. Condition the trap for 10 min once daily prior to use.

7.2 Connect the purge and trap system to a gas chromatograph. The gas chromatograph must be operated using temperature and flow rate conditions equivalent to those given in Table 1. Calibrate the purge and trap-gas chromatographic system using either the external standard technique (Section 7.3) or the internal standard technique (Section 7.4).

7.3 External standard calibration procedure:

7.3.1 Prepare calibration standards at a minimum of three concentration levels for each parameter by carefully adding 20.0 μ L of one or more secondary dilution standards to 100, 500, or 1000 mL of reagent water. A 25- μ L syringe with a 0.006 in. ID needle should be used for this operation. One of the external standards should be at a concentration near, but above, the MDL (Table 1) and the other concentrations should correspond to the expected range of concentrations found in real samples or should define the working range of the detector. These aqueous standards must be prepared fresh daily.

7.3.2 Analyze each calibration standard according to Section 10, and tabulate peak height or area responses versus the concentration in the standard. The results can be used to prepare a calibration curve for each compound. Alternatively, if the ratio of response to concentration (calibration factor) is a constant over the working range (<10% relative standard deviation, RSD), linearity through the origin can be assumed and the average ratio or calibration factor can be used in place of a calibration curve.

7.4 Internal standard calibration procedure—To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the

compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples. The compound, α,α,α -trifluorotoluene, recommended as a surrogate spiking compound in Section 8.7 has been used successfully as an internal standard.

7.4.1 Prepare calibration standards at a minimum of three concentration levels for each parameter of interest as described in Section 7.3.1.

7.4.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Section 8.6 and 8.7. It is recommended that the secondary dilution standard be prepared at a concentration of 15 μ g/mL of each internal standard compound. The addition of 10 μ L of this standard to 5.0 mL of sample or calibration standard would be equivalent to 30 μ g/L.

7.4.3 Analyze each calibration standard according to Section 10, adding 10 μ L of internal standard spiking solution directly to the syringe (Section 10.4). Tabulate peak height or area responses against concentration for each compound and internal standard, and calculate response factors (RF) for each compound using Equation 1.

Equation 1.

$$RF = \frac{(A_s)(C_u)}{(A_u)(C_s)}$$

where:

A_s = Response for the parameter to be measured.

A_u = Response for the internal standard.

C_u = Concentration of the internal standard

C_s = Concentration of the parameter to be measured.

If the RF value over the working range is a constant (<10% RSD), the RF can be assumed to be invariant and the average RF can be used for calculations. Alternatively, the results can be used to plot a calibration curve of response ratios, A_s/A_u , vs. R_s .

7.5 The working calibration curve, calibration factor, or RF must be verified on each working day by the measurement of a QC check sample.

7.5.1 Prepare the QC check sample as described in Section 8.2.2.

7.5.2 Analyze the QC check sample according to Section 10.

7.5.3 For each parameter, compare the response (Q) with the corresponding calibration acceptance criteria found in Table 2. If the responses for all parameters of interest fall within the designated ranges, analysis of actual samples can begin. If any individual Q falls outside the range, a new calibration curve, calibration factor, or RF must be prepared for that parameter according to Section 7.3 or 7.4.

8. Quality Control

8.1 Each laboratory that uses this method is required to operate a formal quality control program. The minimum requirements of this program consist of an initial demonstration of

laboratory capability and an ongoing analysis of spiked samples to evaluate and document data quality. The laboratory must maintain records to document the quality of data that is generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results of sample spikes indicate atypical method performance, a quality control check standard must be analyzed to confirm that the measurements were performed in an in-control mode of operation.

8.1.1 The analyst must make an initial, one-time, demonstration of the ability to generate acceptable accuracy and precision with this method. This ability is established as described in Section 8.2.

8.1.2 In recognition of advances that are occurring in chromatography, the analyst is permitted certain options (detailed in Section 10.1) to improve the separations or lower the cost of measurements. Each time such a modification is made to the method, the analyst is required to repeat the procedure in Section 8.2.

8.1.3 Each day, the analyst must analyze a reagent water blank to demonstrate that interferences from the analytical system are under control.

8.1.4 The laboratory must, on an ongoing basis, spike and analyze a minimum of 10% of all samples to monitor and evaluate laboratory data quality. This procedure is described in Section 8.3.

8.1.5 The laboratory must, on an ongoing basis, demonstrate through the analyses of quality control check standards that the operation of the measurement system is in control. This procedure is described in Section 8.4. The frequency of the check standard analyses is equivalent to 10% of all samples analyzed but may be reduced if spike recoveries from samples (Section 8.3) meet all specified quality control criteria.

8.1.6 The laboratory must maintain performance records to document the quality of data that is generated. This procedure is described in Section 8.5.

8.2 To establish the ability to generate acceptable accuracy and precision, the analyst must perform the following operations.

8.2.1 A quality control (QC) check sample concentrate is required containing each parameter of interest at a concentration of 10 µg/mL in methanol. The QC check sample concentrate must be obtained from the U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory in Cincinnati, Ohio, if available. If not available from that source, the QC check sample concentrate must be obtained from another external source. If not available from either source above, the QC check sample concentrate must be prepared by the laboratory using stock standards prepared independently from those used for calibration.

8.2.2 Prepare a QC check sample to contain 20 µg/L of each parameter by adding 200 µL of QC check sample concentrate to 100 mL of reagent water.

8.2.3 Analyze four 5-mL aliquots of the well-mixed QC check sample according to Section 10.

8.2.4 Calculate the average recovery (\bar{X}) in µg/L and the standard deviation of the recovery (s) in µg/L for each parameter of interest using the four results.

8.2.5 For each parameter compare s and \bar{X} with the corresponding acceptance criteria for precision and accuracy, respectively, found in Table 2. If s and \bar{X} for all parameters of interest meet the acceptance criteria, the system performance is acceptable and analysis of actual samples can begin. If any individual s exceeds the precision limit or any individual \bar{X} falls outside the range for accuracy, the system performance is unacceptable for that parameter.

Note.—The large number of parameters in Table 2 present a substantial probability that one or more will fail at least one of the acceptance criteria when all parameters are analyzed.

8.2.6 When one or more of the parameters tested fail at least one of the acceptance criteria, the analyst must proceed according to Section 8.2.6.1 or 8.2.6.2.

8.2.6.1 Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with Section 8.2.3.

8.2.6.2 Beginning with Section 8.2.3, repeat the test only for those parameters that failed to meet criteria. Repeated failure, however, will confirm a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with Section 8.2.3.

8.3 The laboratory must, on an ongoing basis, spike at least 10% of the samples from each sample site being monitored to assess accuracy. For laboratories analyzing one to ten samples per month, at least one spiked sample per month is required.

8.3.1 The concentration of the spike in the sample should be determined as follows:

8.3.1.1 If, as in compliance monitoring, the concentration of a specific parameter in the sample is being checked against a regulatory concentration limit, the spike should be at that limit or 1 to 5 times higher than the background concentration determined in Section 8.3.2, whichever concentration would be larger.

8.3.1.2 If the concentration of a specific parameter in the sample is not being checked against a limit specific to that parameter, the spike should be at 20 µg/L or 1 to 5 times higher than the background concentration determined in Section 8.3.2, whichever concentration would be larger.

8.3.2 Analyze one 5-mL sample aliquot to determine the background concentration (B) of each parameter. If necessary, prepare a new QC check sample concentrate (Section 8.2.1) appropriate for the background concentrations in the sample. Spike a second 5-mL sample aliquot with 10 µL of the QC check sample concentrate and analyze it to determine the concentration after spiking (A) of each parameter. Calculate each percent recovery (P) as $100(A-B)/T$, where T is the known true value of the spike.

8.3.3 Compare the percent recovery (P) for each parameter with the corresponding QC acceptance criteria found in Table 2. These acceptance criteria were calculated to include an allowance for error in

measurement of both the background and spike concentrations, assuming a spike to background ratio of 5:1. This error will be accounted for to the extent that the analyst's spike to background ratio approaches 5:1. If spiking was performed at a concentration lower than 20 µg/L, the analyst must use either the QC acceptance criteria in Table 2, or optional QC acceptance criteria calculated for the specific spike concentration. To calculate optional acceptance criteria for the recovery of a parameter: (1) Calculate accuracy (\bar{X}) using the equation in Table 3, substituting the spike concentration (T) for C; (2) calculate overall precision (S) using the equation in Table 3, substituting \bar{X} for \bar{X} ; (3) calculate the range for recovery at the spike concentration as $(100 \bar{X}/T) \pm 2.44(100 S'/T)\%$.

8.3.4 If any individual P falls outside the designated range for recovery, that parameter has failed the acceptance criteria. A check standard containing each parameter that failed the criteria must be analyzed as described in Section 8.4.

8.4 If any parameter fails the acceptance criteria for recovery in Section 8.3, a QC check standard containing each parameter that failed must be prepared and analyzed.

Note: The frequency for the required analysis of a QC check standard will depend upon the number of parameters being simultaneously tested, the complexity of the sample matrix, and the performance of the laboratory.

8.4.1 Prepare the QC check standard by adding 10 µL of QC check sample concentrate (Sections 8.2.1 or 8.3.2) to 5 mL of reagent water. The QC check standard needs only to contain the parameters that failed criteria in the test in Section 8.3.

8.4.2 Analyze the QC check standard to determine the concentration measured (A) of each parameter. Calculate each percent recovery (P_s) as $100(A/T)\%$, where T is the true value of the standard concentration.

8.4.3 Compare the percent recovery (P_s) for each parameter with the corresponding QC acceptance criteria found in Table 2. Only parameters that failed the test in Section 8.3 need to be compared with these criteria. If the recovery of any such parameter falls outside the designated range, the laboratory performance for that parameter is judged to be out of control, and the problem must be immediately identified and corrected. The analytical result for that parameter in the unspiked sample is suspect and may not be reported for regulatory compliance purposes.

8.5 As part of the QC program for the laboratory, method accuracy for wastewater samples must be assessed and records must be maintained. After the analysis of five spiked wastewater samples as in Section 8.3, calculate the average percent recovery (\bar{P}) and the standard deviation of the percent recovery (s_p). Express the accuracy assessment as a percent recovery interval from $\bar{P} - 2s_p$ to $\bar{P} + 2s_p$. If $\bar{P} = 90\%$ and $s_p = 10\%$, for example, the accuracy interval is expressed as 70–110%. Update the accuracy assessment for each parameter on a regular basis (e.g. after each five to ten new accuracy measurements).

8.6 It is recommended that the laboratory adopt additional quality assurance practices for use with this method. The specific practices that are most productive depend upon the needs of the laboratory and the nature of the samples. Field duplicates may be analyzed to assess the precision of the environmental measurements. When doubt exists over the identification of a peak on the chromatogram, confirmatory techniques such as gas chromatography with a dissimilar column, specific element detector, or mass spectrometer must be used. Whenever possible, the laboratory should analyze standard reference materials and participate in relevant performance evaluation studies.

8.7 The analyst should monitor both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent water blank with surrogate compounds (e.g., α , α , α -trifluorotoluene) recommended to encompass the range of the temperature program used in this method. From stock standard solutions prepared as in Section 8.6, add a volume to give 750 μ g of each surrogate to 45 mL of reagent water contained in a 50-mL volumetric flask, mix and dilute to volume for a concentration of 15 mg/ μ L. Add 10 μ L of this surrogate spiking solution directly into the 5-mL syringe with every sample and reference standard analyzed. Prepare a fresh surrogate spiking solution on a weekly basis. If the internal standard calibration procedure is being used, the surrogate compounds may be added directly to the internal standard spiking solution (Section 7.4.2).

9 Sample Collection, Preservation, and Handling

9.1 The samples must be iced or refrigerated from the time of collection until analysis. If the sample contains free or combined chlorine, add sodium thiosulfate preservative (10 mg/40 mL is sufficient for up to 5 ppm Cl₂) to the empty sample bottle just prior to shipping to the sampling site. EPA Method 330.4 or 330.5 may be used for measurement of residual chlorine.⁸ Field test kits are available for this purpose.

9.2 Collect about 500 mL of sample in a clean container. Adjust the pH of the sample to about 2 by adding 1 + 1 HCl while stirring. Fill the sample bottle in such a manner that no air bubbles pass through the sample as the bottle is being filled. Seal the bottle so that no air bubbles are entrapped in it. Maintain the hermetic seal on the sample bottle until time of analysis.

9.3 All samples must be analyzed within 14 days of collection.⁹

10. Procedure

10.1 Table 1 summarizes the recommended operating conditions for the gas chromatograph. Included in this table are estimated retention times and MDL that can be achieved under these conditions. An example of the separations achieved by Column 1 is shown in Figure 6. Other packed columns, chromatographic conditions, or detectors may be used if the requirements of Section 8.2 are met.

10.2 Calibrate the system daily as described in Section 7.

10.3 Adjust the purge gas (nitrogen or helium) flow rate to 40 mL/min. Attach the trap inlet to the purging device, and set the purge and trap system to purge (Figure 3). Open the syringe valve located on the purging device sample introduction needle.

10.4 Allow the sample to come to ambient temperature prior to introducing it to the syringe. Remove the plunger from a 5-mL syringe and attach a closed syringe valve. Open the sample bottle (or standard) and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve and vent any residual air while adjusting the sample volume to 5.0 mL. Since this process of taking an aliquot destroys the validity of the sample for future analysis, the analyst should fill a second syringe at this time to protect against possible loss of data. Add 10.0 μ L of the surrogate spiking solution (Section 8.7) and 10.0 μ L of the internal standard spiking solution (Section 7.4.2), if applicable, through the valve bore, then close the valve.

10.5 Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valves and inject the sample into the purging chamber.

10.6 Close both valves and purge the sample for 12.0 \pm 0.1 min at ambient temperature.

10.7 After the 12-min purge time, disconnect the purging device from the trap. Dry the trap by maintaining a flow of 40 mL/min of dry purge gas through it for 6 min (Figure 4). If the purging device has no provision for bypassing the purger for this step, a dry purger should be inserted into the device to minimize moisture in the gas. Attach the trap to the chromatograph, adjust the purge and trap system to the desorb mode (Figure 5), and begin to temperature program the gas chromatograph. Introduce the trapped materials to the GC column by rapidly heating the trap to 180 °C while backflushing the trap with an inert gas between 20 and 60 mL/min for 4 min. If rapid heating of the trap cannot be achieved, the GC column must be used as a secondary trap by cooling it to 30 °C (subambient temperature, if poor peak geometry and random retention time problems persist) instead of the initial program temperature of 50 °C.

10.8 While the trap is being desorbed into the gas chromatograph column, empty the purging chamber using the sample introduction syringe. Wash the chamber with two 5-mL flushes of reagent water.

10.9 After desorbing the sample for 4 min, recondition the trap by returning the purge and trap system to the purge mode. Wait 15 s, then close the syringe valve on the purging device to begin gas flow through the trap. The trap temperature should be maintained at 180 °C. After approximately 7 min, turn off the trap heater and open the syringe valve to stop the gas flow through the trap. When the trap is cool, the next sample can be analyzed.

10.10 Identify the parameters in the sample by comparing the retention times of the peaks in the sample chromatogram with those of the peaks in standard chromatograms. The width of the retention time window used to make identifications should be based upon measurements of

actual retention time variations of standards over the course of a day. Three times the standard deviation of a retention time for a compound can be used to calculate a suggested window size; however, the experience of the analyst should weigh heavily in the interpretation of chromatograms.

10.11 If the response for a peak exceeds the working range of the system, prepare a dilution of the sample with reagent water from the aliquot in the second syringe and reanalyze.

11. Calculations

11.1 Determine the concentration of individual compounds in the sample.

11.1.1 If the external standard calibration procedure is used, calculate the concentration of the parameter being measured from the peak response using the calibration curve or calibration factor determined in Section 7.3.2.

11.1.2 If the internal standard calibration procedure is used, calculate the concentration in the sample using the response factor (RF) determined in Section 7.4.3 and Equation 2.

Equation 2.

$$\text{Concentration } (\mu\text{g/L}) = \frac{(A_s)(C_u)}{(A_u)(\text{RF})}$$

where:

A_s = Response for the parameter to be measured.

A_u = Response for the internal standard.

C_u = Concentration of the internal standard.

11.2 Report results in μ g/L without correction for recovery data. All QC data obtained should be reported with the sample results.

12. Method Performance

12.1 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero.¹ The MDL concentrations listed in Table 1 were obtained using reagent water.⁹ Similar results were achieved using representative wastewaters. The MDL actually achieved in a given analysis will vary depending on instrument sensitivity and matrix effects.

12.2 This method has been demonstrated to be applicable for the concentration range from the MDL to 1000 \times MDL.⁹ Direct aqueous injection techniques should be used to measure concentration levels above 1000 \times MDL.

12.3 This method was tested by 20 laboratories using reagent water, drinking water, surface water, and three industrial wastewaters spiked at six concentrations over the range 2.5 to 550 μ g/L.⁹ Single operator precision, overall precision, and method accuracy were found to be directly related to the concentration of the parameter and essentially independent of the sample

matrix. Linear equations to describe these relationships are presented in Table 3.

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TABLE 1.—CHROMATOGRAPHIC CONDITIONS AND METHOD DETECTION LIMITS

Parameter	Retention time (min)		Method detection limit (µg/L)
	Column 1	Column 2	
Benzene	3.33	2.75	0.2
Toluene	5.75	4.25	0.2
Ethylbenzene	8.25	6.25	0.2
Chlorobenzene	9.17	8.02	0.2
1,4-Dichlorobenzene	16.8	16.2	0.3
1,3-Dichlorobenzene	18.2	15.0	0.4
1,2-Dichlorobenzene	25.9	19.4	0.4

Column 1 conditions: Supelcoport (100/120 mesh) coated with 5% SP-1200/1.75% Bentone-34 packed in a 6 ft x 0.085 in ID stainless steel column with helium carrier gas at 36 mL/min flow rate. Column temperature held at 50 °C for 2 min then programmed at 6 °C/min to 90 °C for a final hold.

Column 2 conditions: Chromosorb W-AW (60/80 mesh) coated with 5% 1,2,3-Tris(2-cyanoethoxy)propane packed in a 6 ft x 0.085 in ID stainless steel column with helium carrier gas at 30 mL/min flow rate. Column temperature held at 40 °C for 2 min then programmed at 2 °C/min to 100 °C for a final hold.

TABLE 2.—CALIBRATION AND QC ACCEPTANCE CRITERIA—METHOD 602*

Parameter	Range for Q (µg/L)	Limit for s (µg/L)	Range for \bar{X} (µg/L)	Range for P, P ₁ (%)
Benzene	15.4-24.6	4.1	10.0-27.9	39-150
Chlorobenzene	16.1-23.9	3.5	12.7-25.4	55-135
1,2-Dichlorobenzene	13.6-26.4	5.8	10.6-27.6	37-154
1,3-Dichlorobenzene	14.5-25.5	5.0	12.8-25.5	50-141
1,4-Dichlorobenzene	13.9-26.1	5.5	11.6-25.5	42-143
Ethylbenzene	12.6-27.4	6.7	10.0-28.2	32-160
Toluene	15.5-24.5	4.0	11.2-27.7	46-148

Q = Concentration measured in QC check sample, in µg/L (Section 7.5.3).

s = Standard deviation of four recovery measurements, in µg/L (Section 8.2.4).

\bar{X} = Average recovery for four recovery measurements, in µg/L (Section 8.2.4).

P, P₁ = Percent recovery measured (Section 8.3.2, Section 8.4.2).

* Criteria were calculated assuming a QC check sample concentration of 20 µg/L.

Note: These criteria are based directly upon the method performance data in Table J. Where necessary, the limits for recovery have been broadened to assure applicability of the limits to concentrations below those used to develop Table 3.

TABLE 3.—METHOD ACCURACY AND PRECISION AS FUNCTIONS OF CONCENTRATION—METHOD 602

Parameter	Accuracy, as recovery, \bar{X} (µg/L)	Single analyst precision, s (µg/L)	Overall precision, S (µg/L)
Benzene	0.92C + 0.57	0.09 \bar{X} + 0.59	0.21 \bar{X} + 0.56
Chlorobenzene	0.95C + 0.02	0.09 \bar{X} + 0.23	0.17 \bar{X} + 0.10
1,2-Dichlorobenzene	0.93C + 0.52	0.17 \bar{X} + 0.04	0.22 \bar{X} + 0.53
1,3-Dichlorobenzene	0.98C + 0.04	0.15 \bar{X} + 0.10	0.19 \bar{X} + 0.09
1,4-Dichlorobenzene	0.93C + 0.09	0.15 \bar{X} + 0.28	0.20 \bar{X} + 0.41
Ethylbenzene	0.94C + 0.31	0.17 \bar{X} + 0.46	0.26 \bar{X} + 0.23
Toluene	0.94C + 0.65	0.09 \bar{X} + 0.48	0.18 \bar{X} + 0.71

\bar{X} = Expected recovery for one or more measurements of a sample containing a concentration of C, in µg/L.

s = Expected single analyst standard deviation of measurements at an average concentration found of \bar{X} , in µg/L.

S = Expected interlaboratory standard deviation of measurements at an average concentration found of \bar{X} , in µg/L.

C = True value for the Concentration, in µg/L.

\bar{X} = Average recovery found for measurements of samples containing a concentration of C, in µg/L.

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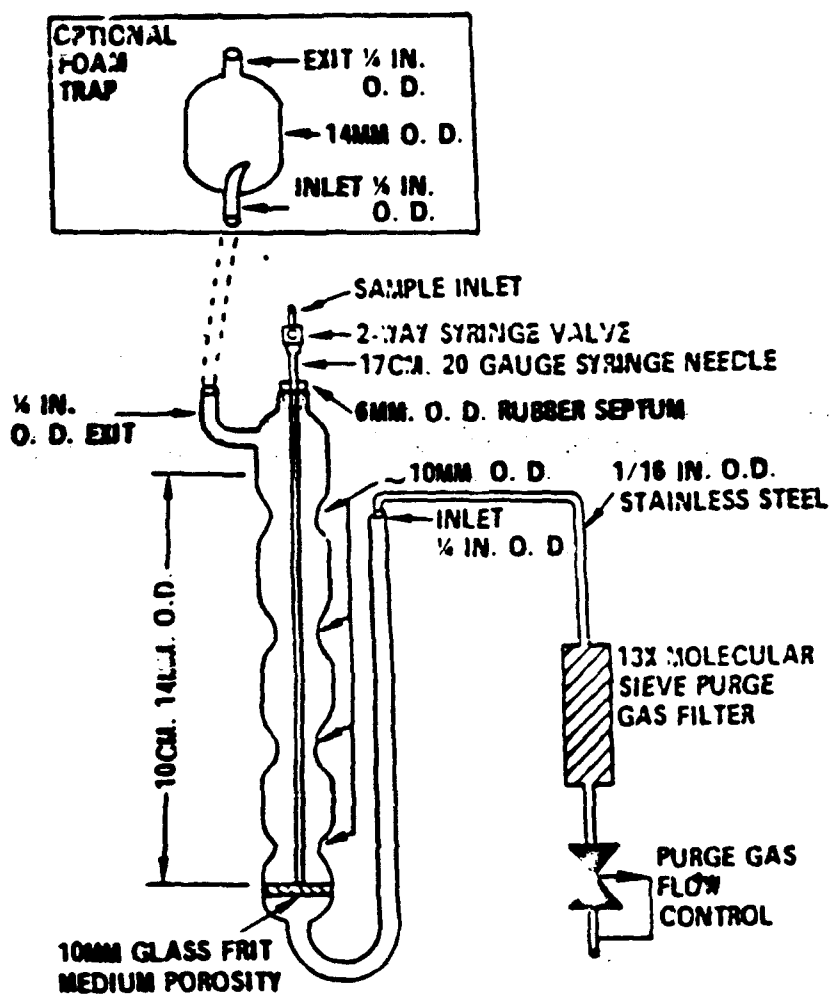


Figure 1. Purging device.

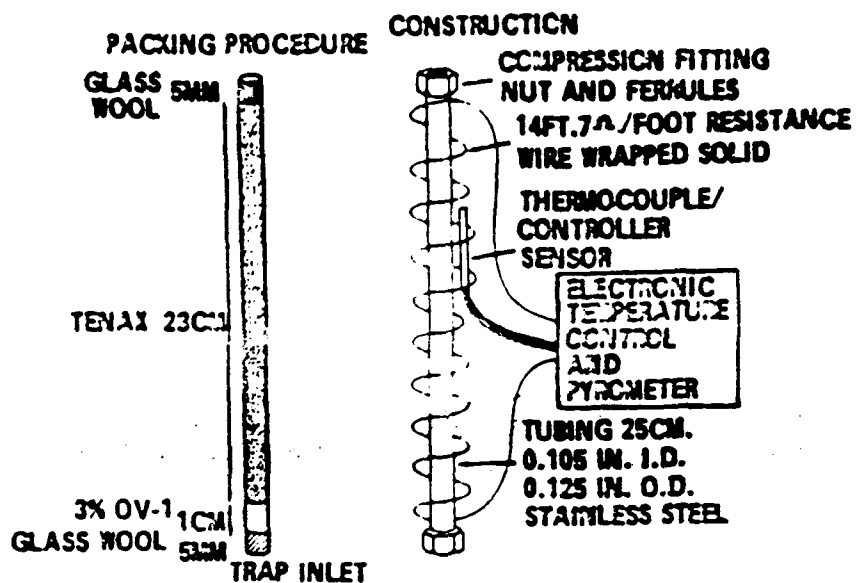


Figure 2. Trap packings and construction to include desorb capability.

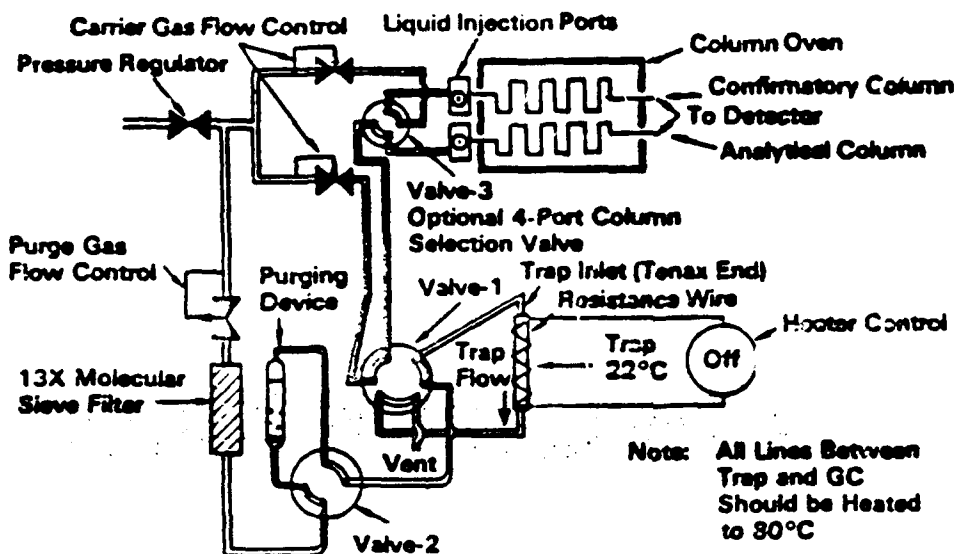


Figure 3. Purge and trap system - purge mode.

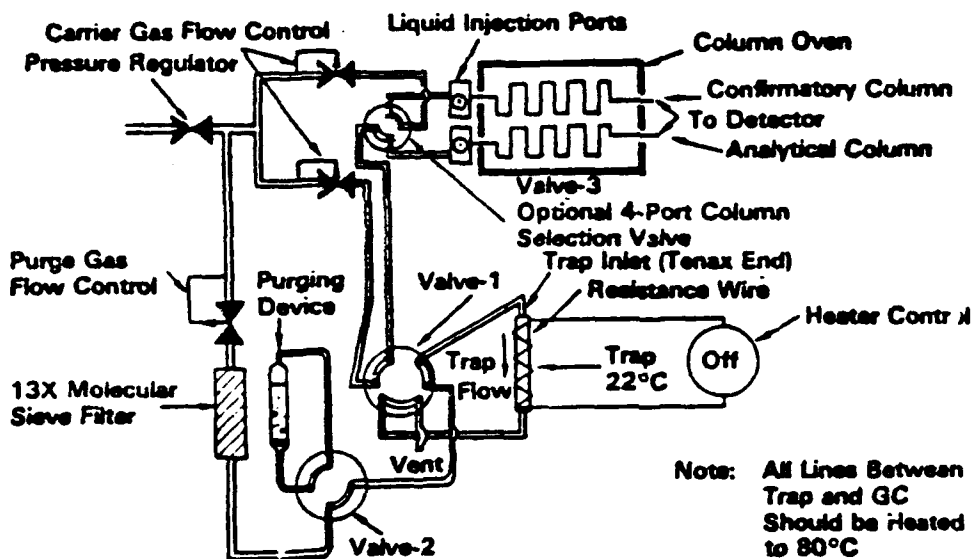


Figure 4. Purge and trap system-dry mode.

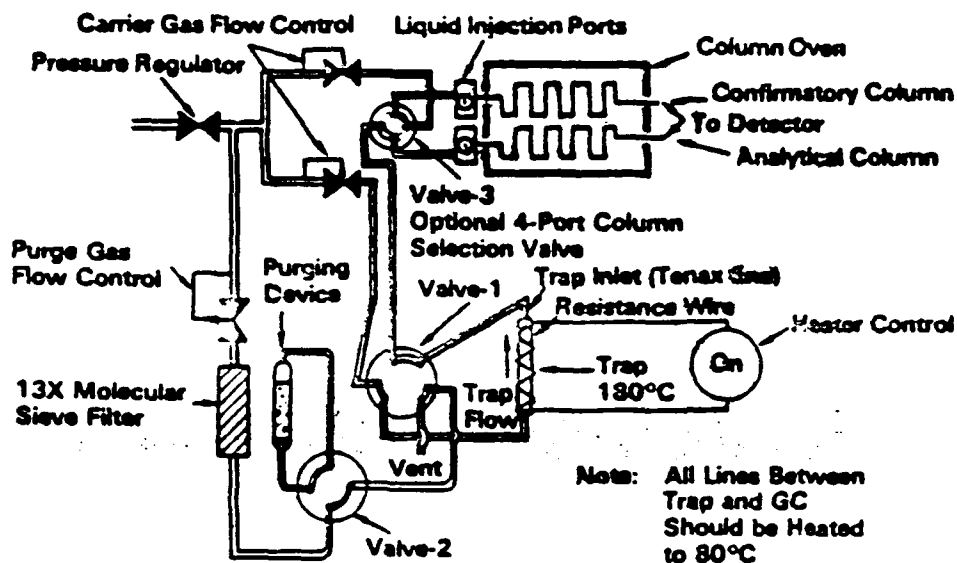


Figure 5. Purge and trap system-desorb mode.

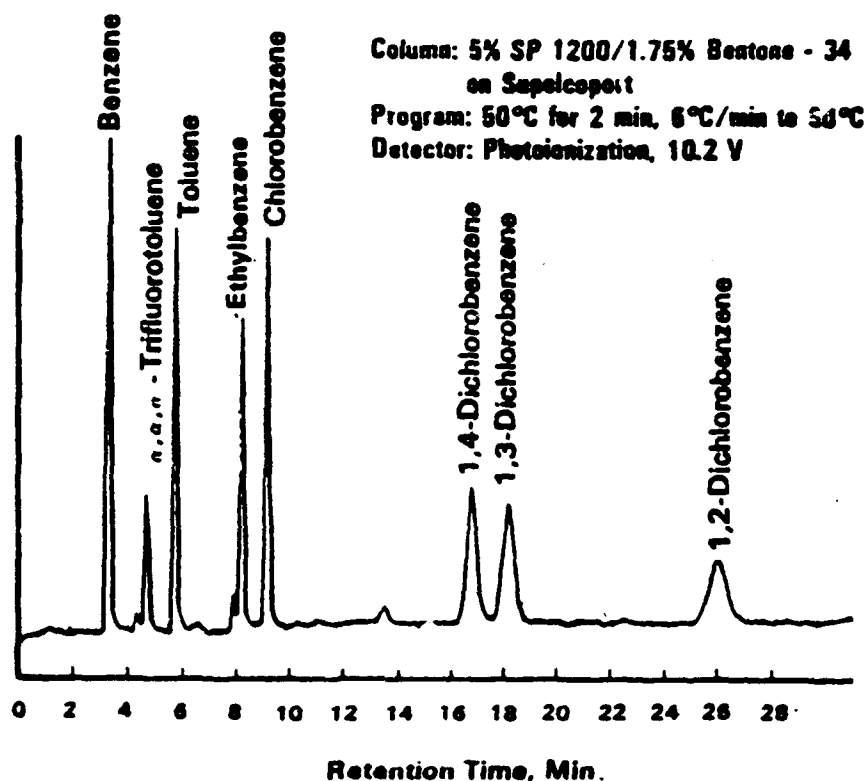


Figure 6. Gas chromatogram of purgeable aromatics.

APPENDIX H

LABORATORY QA/QC PLAN

WESTON ANALYTICAL LABORATORY QUALITY ASSURANCE PLAN
11/30/84

TABLE OF CONTENTS

CHAPTER	PAGE
1.0 Introduction	1-1
2.0 Sample Handling Procedures	2-1
2.1 Analysis Plan	2-1
2.2 Bottle Preparation	2-2
2.3 Sample Preservatives	2-2
2.4 Chain of Custody Documentation	2-3
2.5 Sample Management System	2-3
2.6 Sample Storage	2-4
2.7 Sample Retention and Disposal	2-5
3.0 Standard Operating Procedures	3-1
3.1 Analytical Methods	3-1
3.2 Documentation of the Analytical Procedure	3-1
4.0 Analytical Laboratory Quality Control	4-1
4.1 Analytical Method Calibration	4-1
4.1.1 Initial Calibration	4-1
4.1.2 Shift Calibration	4-1
4.1.3 Re-calibration	4-2
4.2 Lot Size	4-2
4.3 Quality Control Samples	4-2
4.3.1 Quality Control Blanks	4-2
4.3.1.1 Reagent Blank	4-2
4.3.1.2 Method Blank	4-3
4.3.2 Analytical Reference Standard	4-3
4.3.2.1 Calibration Check Standard	4-3
4.3.3 Standard Matrix Spike Sample	4-3
4.3.4 Quality Control Sample Summary	4-4
4.4 Quality Control Charts	4-4
4.5 Quality Control for Reporting Results	4-4
4.5.1 Detection Limit	4-4
4.5.2 Significant Figures	4-6

CHAPTER	PAGE
4.5.3 Units	4-6
4.5.4 Analytical Modifications	4-6
4.5.5 Final Result Review	4-6
4.5.6 Deliverables	4-8
4.5.7 Data Archiving System	4-8
4.6 Out of Control Situations	4-8
4.6.1 Blanks	4-9
4.6.2 Duplicate Samples and Fortified and Reagent Blanks	4-9
4.6.3 Calibration Check Standard	4-9
4.6.4 Sample Cross Contamination or Interference	4-9
4.6.5 Instrument Malfunction	4-10
4.7 Corrective Action	4-10
4.8 Instrument Maintenance and Calibration	4-11
4.8.1 Maintenance Information	4-11
4.8.2 Calibration Information	4-11
5.0 Quality Assurance	5-1
5.1 Organization	5-1
5.2 Responsibilities of the QA Organization	5-1
5.2.1 Internal Audits	5-1
5.2.2 Third Party Audits	5-1
5.2.3 Out of Control Audits	5-1
5.2.3.1 Termination of an Analytical Procedure	5-1
5.2.3.2 Restart of Terminated Analytical Procedures	5-2
5.2.4 Quality Control Sample Results	5-2
5.2.5 Reports and Deliverables	5-3
5.2.5.1 Quarterly QA Reports	5-3
5.2.5.2 Annual QA Reports	5-3
5.2.5.3 Out of Control Report	5-3
5.2.5.4 Project QA Report	5-3
5.2.5.5 Third Party Performance Sample Report	5-3
5.2.5.6 A Non-Compliance Report	5-3
5.2.5.7 WESTON Analytical Laboratory QA/QC Manual	5-4
6.0 Subcontracted Analyses	6-1

1.0 INTRODUCTION

The objective of a standard quality assurance-quality control plan is to establish and delineate the minimum amount of effort the WESTON analytical laboratory will perform on every sample submitted for analysis. This plan is designed to meet four goals for the data from environmental analysis carried out by a WESTON laboratory. They are:

- Define WESTON standard of quality.
- Provide legally defensible analysis
- A published standard for comparison of price and quality
- A published standard for the purpose of building or modifying a sampling and analytical program that addresses the requirements of the project.

If project requirements necessitate different quality assurance programs, the user of WESTON analytical laboratory services is responsible for defining and identifying all deviations from the standard QA/QC plan. All changes must be documented in writing for approval by the manager of the WESTON laboratory involved.

2.0 SAMPLE HANDLING PROCEDURES

In order to meet the stated goals for the standard QA/QC plan the client and the analytical laboratory must understand and follow the rules for handling the samples within the laboratory. These rules treat the sample collector as an integral part of the laboratory team in achieving the correct analyses for the sample. Sampling handling procedures include:

- Analysis Plan
- Bottle Preparation
- Sample Preservatives
- Chain of Custody Documentation
- Sample Management System
- Sample Storage
- Analysis Scheduling
- Sample Retention and Disposal

2.1 Analysis Plan

The analysis plan is a written document that consists of the following information:

- Name of the client
- Project Director and Project Manager
- Pertinent organization information (i.e., work order numbers, name of client).
- List of parameters to be analyzed
- Number of samples listed by parameter and matrix
- Price
- Projected date and time of sample arrival at the laboratory
- List of all exceptions to the Standard Analytical Plan and the Standard QA/QC Plan
- List all the extra considerations not included in the Standard QA/QC Plan (i.e., field blanks, USATHAMA QA/QC, specific data reporting requirements).

The analysis plan must be a written document. It must be submitted to the analytical laboratory to be approved by the manager before the samples are collected. All deviations to the analysis plan must be documented in writing by either the client or the laboratory. This document must be approv-

* The Standard Analytical Plan consists of the specific methodology used by the analytical laboratory for a given parameter and matrix. This document includes a brief description of the method, an estimated detection limit, and a source reference for the method.

ed by the laboratory and project manager within the holding time of the parameter of concern or 48 hours, whichever is less. No analysis will be performed in a WESTON analytical laboratory without the proper and complete analysis plan on file.

2.2 Bottle Preparation

Sample bottles will be prepared by the analytical laboratory and made available to the sampling team on the required date in the analysis plan. The bottles will be prepared according to WESTON Standard Operating Procedures. If samples are submitted to the laboratory in bottles or containers prepared by others, this deviation must be specified in the analysis plan along with the sample bottle preparation protocols employed and the person/company responsible for preparing the bottles.

2.3 Sample Preservatives

All sample bottles prepared by the analytical laboratory will contain the preservative(s) shown in the WESTON Analysis Plan. The amount of the preservative placed in the sample bottle for aqueous samples will be adequate and proper for water samples. To ensure that a sample is properly preserved after collection (especially where preservation requires pH adjustment), field personnel are urged to check the pH of the sample after preservation. These data should be recorded in field notebooks.

All samples submitted will be checked to insure the proper preservative and preservation procedures were used for the sample. This includes the following checks where appropriate:

I Normal

- pH
- Temperature of 4°C

II Special at Discretion of Lab

- Color
- Observation of sample for particulates or air bubbles (VOA).
- Anion spot test for SO_4^{--} and Cl^- (TOC)

All observations will be recorded by laboratory personnel and no sample will be analyzed unless;

- it is properly preserved
- the client has authorized the sample analysis by a written amendment to the analysis plan or WESTON Standard QA/QC plan as prescribed in Section 2.1

2.4 Chain of Custody Documentation

All samples must arrive at the laboratory with a chain of custody document. A copy of the chain of custody document is contained in the "Tracking System". The laboratory will provide EPA-approved sample bottle labels, chain of custody forms, and shipping containers upon request. The chain of custody document must be initiated at the time the sample bottles are prepared. If the sample bottles are not prepared by the analytical laboratory then the client assumes responsibility for proper bottle selection and preparation. The chain of custody document submitted in this case should include the bottle preparation and sample preservation information.

When samples are delivered to the laboratory, the information on the chain of custody document must be complete in full. The samples will be inventoried against the chain of custody form, and custody transfer acknowledged by signature, date and time of receipt. A copy of the signed form will be given to the personnel who delivered the samples.

For samples which are delivered without applicable or with incomplete chain of custody documentation, the sample custodian will initiate a chain of custody or note acknowledges receipt of the samples and initiates laboratory custody.

FOR SAMPLES WHICH ARE RECEIVED WITHOUT PROPER CHAIN OF CUSTODY, OR DEFICIENT CHAIN OF CUSTODY, THE LEGAL TRACEABILITY OF SAMPLES BEGINS WITH RECEIPT AT THE LABORATORY BUT DOES NOT EXTEND TO THE POINT OF SAMPLE COLLECTION.

2.5 Sample Management System

Upon arrival at the laboratory, the sample will be either logged-in immediately or stored at 4°C until log-in procedures can be initiated. The log-in process for any given shipment of samples must be completed within 24 hours of sample arrival at the laboratory as noted on the chain of custody document. The log in data will be available to the submitter (Project Manager) within 48 hours after arrival of the samples at the laboratory to verify completeness of the sample submittal. Deviations from the analysis plan must be noted and resolved by both parties at this time.

The sample management system will be used for the following laboratory functions:

- Scheduling
- Sample Disposal
- Invoicing (See Pricing Schedule for the appropriate analytical laboratory)
- Data Management
- Deliverable Preparation

It is imperative that the field documentation provided by field personnel and the sample log-in procedure in the analytical laboratory be complete and accurate. Resolution of deviations from the analysis plan must be accomplished within the holding time of the parameter of concern or 48 hours. Resolution of these items must be accomplished by telephone, followed by written documentation in order to complete the analysis within the required holding time. The holding times are summarized in the Analysis Plan.

Each sample container is assigned a sequential WESTON sample number. This unique WESTON number will identify the sample (and any extracts derived from the sample) in the laboratory's internal chain of custody until proper disposal of samples or extracts. All references to a sample in any communications should include this sample number as well as the site identification number (code).

For additional information see WESTON's Analytical Laboratory's Sample Tracking Document.

This program provides "cradle to grave" chain of custody documentation.

2.6 Sample Storage

All samples will be stored in a locked refrigerator at $4^{\circ}\pm 1^{\circ}\text{C}$. Temperature of storage refrigerators are monitored daily by laboratory personnel. They will be removed from storage by a limited number of authorized WESTON personnel for either analysis, long term retention or disposal. All sample movement will be documented using the laboratory

* WESTON's chain of custody program includes the following:

- Sample bottle preparation
- Sample preservatives
- EPA-approved sample bottle labels and chain of custody documents
- Secured shipping containers
- Laboratory access limited to authorized personnel
- Locked refrigerated storage
- Internal laboratory chain of custody documentation for all analytical operation, including sample disposal.
- All chain of custody documentation includes the location, persons involved, date, time and reason for sample dislocation.
- Signing and dating of all laboratory documentation pertaining to sample receipt, preparation and analysis.

chain of custody documentation. Sample extracts or digested samples will receive the same consideration. During non-working hours, no sample will remain unattended without being placed in a secure area.

2.7 Sample Retention and Disposal

All samples will be retained in the refrigerator for 30 calendar days after the date on the invoice accompanying the final analytical results. Unless there is a written request for sample retention in the analysis plan or a written amendment to the analysis plan, then all samples will receive proper disposal on the 31st calendar day after the invoice date. (See Price List for retention and disposal costs).

3.0 STANDARD OPERATING PROCEDURES

3.1 Analytical Methods

All of the analytical laboratory's methods are listed in the Standard Analysis Plan. Since the choice of method depends on the parameter, the matrix, possible interferences, cost, and detection limit desired, the Standard Analysis Plan denotes the method that will be used by the analytical laboratory unless the analysis plan specifically states that another method must be used. A rationale should accompany this choice of method in the analysis plan.

3.2 Documentation of the Analytical Procedure

All data and observations will be recorded into a bound laboratory notebook. The entries will include:

- Analyst
- Date, Starting and Completion times
- Calibration Data
- Results of analysis of laboratory quality control samples
- Order of Analysis
- Example calculations
- Method reference
- Instrument identification
- Location of raw and final data

All deviation from the method and pertinent observations will be recorded in the laboratory notebook and noted in the data summary report. Also, all "out of control" situations observed by the quality control program must be documented in the notebook. This includes all corrective actions taken by the analyst, supervisor, and/or the laboratory QA/QC coordinator in response to the "out of Control" situation.

4.0 ANALYTICAL LABORATORY QUALITY CONTROL

4.1 Analytical Method Calibration

4.1.1 Initial Calibration

For all parameters utilizing a calibration curve for quantification, the analytical laboratory will measure the response to a reagent blank and at least five (5) different concentrations of the analyte. A modification of the method of Hubaux and Vos will be used to determine the following:

- The acceptable linear concentration range for quantitation (the correlation coefficient (R) must be > 0.996).
- The instrumental detection limit.

At least three (3) calibration concentrations must be in the range of responses that is above the calculated detection limit and used for calculating the acceptable linear concentration range. No response can be reported for a sample if the response is:

- greater than the response of the most concentrated calibration standard used in calculating the acceptable linear concentration range.
- less than the response of the calculated detection limit.
- less than the response of the lowest concentration calibration standard if the response of the calculated detection limit is less than the response of the lowest calibration standard used.

4.1.2 Shift Calibration

Since the objective of the QC program is to verify that analytical accuracy and precision are in control for a given method - instrument - parameter, the initial instrument calibration must be verified periodically. This requires the analysis of at least one calibration standard within the range of initial calibration. The

* Analytical Chemistry, Vol. 42, No. 8, July 1970, p. 849

ongoing calibration data will be checked to verify that it is within $\pm 10\%$ of the initial calibration. A minimum of one shift calibration every 8-12 hours if the instrumental systems is automated for continuous operation.

4.1.3 Re-calibration

Recalibration is required after:

- Instrument repair and/or maintenance.
- A shift calibration does not meet previous calibration criteria.
- Any "out of control" situation as defined in Section 4.6.

4.2 Lot Size

The quality control samples are assigned to each lot of analytical samples. The size of a lot can be dictated by the number of samples that can be completed in a shift by an analyst. Therefore, the size of a lot can vary, but, the variance should not be more than 20%.

4.3 Quality Control Samples

Every lot, regardless of size, will have the following quality control samples included.

- Blanks
- Calibration Standards
- Duplicate (Split Sample)
- Spike (Standard Matrix spike)

Note: That if a lot contains 20 samples, at least one of the samples will be analyzed in duplicate. If a client submits less than 20 samples for analysis and desires one of those samples be analyzed in duplicate, the laboratory must be notified prior to sample receipt.

4.3.1 Quality Control Blanks

4.3.1.1 Reagent Blank

The reagent blank is an integral part of the calibration procedure. It consists of the solvent or matrix used for the calibration standards without the presence of the analyte being measured.

The analytical laboratory will use solvents and reagents of the highest purity available to minimize laboratory contamination. Also, the water quality of the deionized - carbon treated "pure" water system will be monitored monthly.

4.3.1.2 Method Blank

The method blank is a matrix as similar to that of the analytical sample as possible without the presence of the analyte. The method blank is prepared and analyzed with the samples and is used to monitor laboratory contamination.

4.3.2 Analytical Reference Standards

Calibration and spiking standards will be traceable standard materials supplied by or traceable where possible to a federal government agency such as EPA, NBS, or USATHAMA. Where this is not possible, analytical standards of highest available purity will be purchased from available commercial suppliers.

4.3.2.1 Calibration Check Standard

When the analyses a lot of analytical samples along with the required QC samples are complete, a check calibration standard will be analyzed. A check calibration standard is one of the calibration standard solutions used to develop the analytical calibration. This calibration standard must be in the acceptable linear concentration range of the calibration curve. Acceptability of the response to calibration check standard is determined by the QC chart as discussed in sections 4.4 and 4.6.

4.3.3 Standard Matrix Spike Sample

In each analytical sample lot one sample will be a standard matrix spike consisting of a matrix as similar as possible to the matrix of the analytical samples in the lot. The analyst will spike one of these with a known amount of the analyte with the acceptable calibration concentration range. The standard matrix spike sample is carried through the method as an analytical sample. In most cases laboratory reagent water and/or a "clean" soil will be used for the matrix. The results of this spike sample will be used to monitor analytical accuracy.

4.3.4 Quality Control Sample Summary

Assuming that the analytical lot size for a parameter is twenty (20), the analyst would follow the hypothetical analysis order shown in Table 1.

4.4 Quality Control Charts

Three QC charts will be constructed for each analytical method (instrument - parameter) excluding the analyst. The analyst will have his or her own code on the QC chart. The QC charts are:

- An accuracy QC chart based on the % recovery of the standard matrix spike sample.
- A precision QC chart based on the relative mean difference between the results obtained from the analysis of duplicate sample aliquots.
- A precision QC chart based on the reproducibility of the initial and shift calibration slope.
- A Quality Control chart for monitoring ongoing calibration.

The details of the QC chart construction with examples are contained in the WESTON Analytical Laboratory Quality Assurance - Quality Control Manual.

4.5 Quality Control for Reporting Results

4.5.1 Detection Limit

There are three detection limits derived from the method and the analytical experiment.

- Estimated detection limit.
- Detection limit calculated from the calibration data.
- The lowest concentration of the analyte in any calibration standards.

None of the above detection limits applies to a real environmental matrix for the analyte of concern. In most cases the actual detection limit will be equal to or greater than the instrumental detection limit which is reported. Upon request, the actual detection limit for a given matrix can be experimentally determined or estimated.

Table 1

Hypothetical Order of Analysis for a Lot
Size of 20 Analytical Samples

<u>Run #</u>	<u>Description</u>	<u>Comments</u>
1	Reagent Blank	Shift Calibration
2	Standard #1	Shift Calibration
3	Standard #2	Shift Calibration
4	Standard #3	Shift Calibration
5-11	Analytical Samples #1-7	
12	Duplicate of Analytical Sample #5	QC Sample
13-16	Analytical Samples #8-11	
17	Standard Matrix Spike	QC Sample
18-24	Analytical Samples #12-18	
25	Method Blank	QC Sample
26-27	Analytical Samples #19-20	
28	Calibration Check Sample	QC Sample

Notes: (a) A new lot can be analysed without a shift calibration if there are no "out of control" situations and the analyst remains the same. (i.e. return to run #5 and continue through run #28)

(b) Four (4) QC samples are required per lot of 20. This is $16 \frac{2}{3}\%$ of the runs.

The analytical laboratory will report experimentally observed detection limit from the calibration data. The latter concentration will be the higher concentration value of either the value obtained from the calibration for regression analysis or the lowest concentration calibration standard run.

4.5.2 Significant Figures

The general rule for the application of significant figures to analytical environmental data is shown in Table 2.

4.5.3 Units

A few environment analytical parameters have their own respective units such as pH, specific conductivity and turbidity. Most concentrations will be reported in one of two units. Concentrations for liquid samples will be reported in micrograms per liter (ug/L or ppb). Concentrations for solid samples will be reported as micrograms per kilogram (ug/Kg/ppg) dry weight. Any deviation from this reporting format will appear in a footnote form.

4.5.4 Analytical Modifications

All changes and rationale for the changes from the published WESTON Standard Analysis Plan, WESTON Standard QA/QC Plan and the project's analysis plan will be placed into a cover letter/report to the client accompanying the final results and invoice.

4.5.5 Final Data Review

All analytical laboratory results will be reviewed by the laboratory technical managers for the following items:

- Completeness
- Reasonableness
- Conformance with the WESTON Standard Analytical Plan, WESTON Standard QA/QC Plan and the project's analysis plan.
- Data above a regulatory limit, where appropriate.
- Approval of the data by appropriate Section Manager.

Table 2

Relationship of the Experimentally Found Detection Limit, Analyte Concentration and Significant Figures in the Final Result

<u>Detection Limit</u>	<u>Concentration Range</u>	<u># of Significant Figures</u>
1	1 - 10	1
1	10 - 1000	2
1	1000	3

Example: Detection Limit of 100 ug/Kg

<u>Concentration Found</u>	<u>Concentration Reported</u>
84.3 ug/Kg	ND
436.2 ug/Kg	400. ug/Kg
2178.6 ug/Kg	2200. ug/Kg
654266.5 ug/Kg	654000. ug/Kg

4.5.6 Deliverables

The client will receive the following when the analyses have been completed by the laboratory.

- Analytical Data including instrumental detection limits.
- Assurance that the WESTON Standard Analytical Plan, WESTON Standard QA/QC Plan and the project's analysis plan were followed.
- Assurance that all quality control samples were in control.
- A cover letter.
- Invoice

The client will not receive the following unless specifically requested in writing (preferably in the analysis plan):

- Raw data
- QC sample results (except for surrogate recoveries for GC/MS analyses.)
- Pertinent QC charts
- EPA, USATHAMA or other specialized data reports.

4.5.7 Data Archiving

The analytical laboratory will maintain on file, all the raw data, laboratory notebooks, and other documentation pertinent to the work on a given project. This file will be maintained in locked storage for five (5) years from the date of the invoice unless a written request is submitted for changes the retention time.

Data Retrieval from archives will be handled in a similar fashion to a request for analysis; specifically a written request, chain of custody, quotation, three week turn-around time, etc.

4.6 Out of Control Situations

An "out of control" situation occurs when there are experimental data for laboratory quality control samples which suggest that an analytical result may be of questionable or unknown validity. It is the duty of the analyst to identify the "out of control" situation and notify the supervisor. The supervisor will then recommend the appropriate corrective action. (e.g. reanalysis, recalibration, etc.). The out of control situation and corrective action will be documented. The analysis of QC sam-

ples monitors precision, accuracy and laboratory contamination for a particular analysis. The criteria for identifying out of control situations for laboratory QC samples are discussed below:

4.6.1 Blanks

Any reagent or method blank which contains any analyte greater than five (5) times the published detection limit for the method - instrument - parameter analytical system is "out of control". Corrective action is required.

4.6.2 Duplicate Samples and Fortified Reagent Blanks (Standard Matrix Spike)

Any result from a split sample or a fortified reagent blank that fulfills the following criteria for "out of control" on the respective QC chart (See the QA Manual) method/parameter requires corrective action and/or written explanation for the acceptance of the data without any corrective action.

- Any result that exceeds ± 3 standard deviation of the control value.
- The 5th consecutive value that has shown an increasing or decreasing trend.
- The 7th consecutive value on the same side of the central line (mean).

The results from analysis of duplicate samples can be misleading where matrix homogeneity is a problem (e.g. soil, sludges, sediments, multiphase liquid samples) because of the difficulty in obtaining replicate representative aliquots for analysis.

In these cases a written explanation (cover letter) will be provided for data interpretation.

4.6.3 Calibration Check Standard

Any calibration check standard that fulfills the criteria for "out of control" on the QC chart as delineated in section 4.6.2 requires corrective action.

4.6.4 Sample Cross Contamination or Interference

Any sample where there is any suspected cross contamination from the previously analyzed sample must be regarded as "out of control". Cross contamination

tion usually occurs after analysis of sample with relatively high concentrations of analytes or interfering compounds. Therefore, the analyst must be aware of such occurrences. To verify the result, the sample must be reanalyzed immediately after an acceptable blank run and the data for the reanalysis compared with the original. Data will be carefully reviewed (e.g. order of analysis, historical data) by analysts and supervisors to ensure that the data accurately represents the sample. (see section 4.5.5)

4.6.5 Instrument Malfunction

Any instrument malfunction is considered as a situation that necessitates corrective action (see section 4.7). Written documentation of the malfunction and corrective action is mandatory (see section 4.8).

4.7 Corrective Action

All "out of control" situations require immediate attention and corrective action. This corrective action will be as follows:

- The analyst will immediately notify the appropriate supervisor and document the out of control situation in the laboratory notebook.
- The supervisor will notify, in writing, the laboratory manager within 24 hours of the "out of control" situation, corrective action taken and result of corrective action. A copy will be provided to the laboratory QA coordinator.
- The laboratory manager will notify the WESTON Analytics office of any "out of control" situations that have not been corrected within 48 hours of their occurrence. A copy will be sent to the Vice President of Quality Assurance and Finance and the Vice President of EEOD. A written report on the corrective is required when the analyses are in control.

Corrective action requires the following steps:

- Analyses to be stopped immediately for the analyte which is determined "out of control". No further analyses for that analyte can be performed until the "out of control" situation is corrected.
- Notification as shown above.

- Complete documentation in laboratory notebooks of circumstances pertaining to the "out of control" situation and corrective action(s) taken.

The laboratory manager must initial the documentation of the successful corrective action after its completion and must approve resumption of analysis. All of the samples affected by the "out of control" situation must be reanalyzed. Data for any samples of an affected lot which are not reanalyzed must be accompanied by clarification for this decision.

4.8 Instrument Maintenance and Calibration

Each instrument in the analytical laboratory will have a bound maintenance log for documenting instrument maintenance. This maintenance log will be available near the instrument at all times and will be kept current.

4.8.1 Maintenance Information

The following maintenance information is required to be recorded in the maintenance log.

- Detailed statement of maintenance activities including time and date of maintenance and name of person performing maintenance.
- Any telephone call regarding service/maintenance (phone records) and service reports will maintained in the maintenance log.
- Routine maintenance schedule should appear with a check list in the front of the maintenance log.

Instrument Manuals should be maintained in a central file and should be available as necessary.

4.8.2 Calibration Information*

The following instrument calibration information should be recorded in the laboratory notebook (see Sec. 4.1).

* Calibration of some laboratory instruments such as a pH meter, is inconsistent with calibration criteria described in Section 4.1. These instruments will have specific SOPs written for calibration. The instruments which are included in this category are so noted in the WESTON Analytical Laboratory QA/QC Manual.

- Instrumental conditions which are used.
- Time and date.
- Lot(s) to be analyzed
- Calibration data including slope of calibration line and; correlation coefficient of calibration data (response vs concentration).
- The detection limit- (calculated from the calibration data or the lowest concentration calibration standard).
- The acceptable linear concentration range of calibration.

5.0 QUALITY ASSURANCE

5.1 Organization

The corporate quality assurance function is defined in the Corporate OP-03-07. The analytical laboratory portion of the QA organization is shown in Figure 1. This organization is specifically designed to allow independent audit of the laboratory analytical operations. There are no administrative supervisory relationships between the laboratory management and WESTON Analytics, including the laboratory QA coordinator.

5.2 Responsibilities of the QA Organization

5.2.1 Internal Audits

Continuous audit of the analytical laboratory will be performed in order to ascertain and ensure compliance with the WESTON Standard QA/QC Plan, WESTON Standard Analytical Plan, the WESTON analytical laboratory QA/QC Manual and project analysis plans.

5.2.2 Third Party Audits

Arranging for and scheduling third party audits will be the responsibility of the QA coordinator and laboratory manager. This will include:

- Preparation of the analysis plan for all third party performance samples.
- Review all the results and documentation for third party performance samples.
- Approve in writing all final reports and documentation for third party performance samples.

5.2.3 "Out of Control" Audits

All "out of control" events will be continuously audited.

5.2.3.1 Termination of an Analytical Procedure

The Director of QA/QC Programs has the authority after notice (see Sec. 4.7) to terminate an analytical procedure due to the lack of compliance with any single aspect of the WESTON Standard QA Plan, WESTON Standard Analytical Plan, or WESTON Analytical Laboratory QA/QC Manual.

5.2.3.2 Restart of Terminated Analytical Procedures

The Director of QA/QC Programs must approve the restart of any analytical procedures which are "out of control" and have been terminated.

5.2.4 Quality Control Sample Results

Results of analysis of all quality control samples must be reviewed and approved in writing by the laboratory QA coordinator. These samples are required by the WESTON Standard QA/QC Plan and include all third party performance samples, and all blind WESTON QC samples. As described in detail in the WESTON Analytical Laboratory QA/QC Manual the following QA samples may be required as part of a project QA program.

- Blanks
 - Reagent Blank*
 - Method Blank*
 - Trip Blank**
 - Field Blank
- Replicates
 - Field duplicate samples (or replicate)
 - Laboratory split samples
- Spikes
 - Field spiked sample (one sample of field split-samples).
 - Laboratory matrix spiked sample.
 - Laboratory standard matrix spiked sample*.
- Performance Samples
 - Third party samples
 - WESTON "blind" samples

* Samples required by the WESTON Standard QA/QC Plan. Results of these samples will be checked on a parameter basis during routine audits unless specifically requested by the project analysis plan.

** These samples are currently not required by the standard laboratory QA/QC plan. However for specific analyses (e.g. analysis of volatile organic compounds in aqueous samples) it is important that the persons collecting the samples give strong consideration to including field and trip blanks in the samples submitted for analysis. This requirement will be addressed in the preparation of the project sampling and analysis plan.

5.2.5 Reports and Deliverables

5.2.5.1 Quarterly QA Reports

A quarterly QA report to the Director of QA/QC Programs must be prepared by WESTON Analytics by the 15th of January, April, July, and October of each year. The quarterly report will be a summary of all laboratory audit results, results from blind samples, performance samples, and project analysis plan QA samples, and "out of control" situations. Recommendations for future improvements and actions must be included in this report.

5.2.5.2 Annual QA Report

An annual QA report will be prepared by WESTON Analytics by January 15 of each year. The annual report will summarize activities and performance of the total WESTON QA system as it relates to analytical laboratories. QA/QC goals for the next year with appropriate action plans, milestones, and costs are to be included in the report.

5.2.5.3 "Out of Control" Report

The report required by Section 4.7 must be reviewed by the laboratory QA coordinator. The report with QA coordinator comments will be forwarded through WESTON analytics to the Director of QA/QC Programs.

5.2.5.4 Project QA Report (special project requirement)

If the project analysis plan requires the analysis of any QC samples(s) beyond those required by the laboratory QC plan or requires an audit of data documentation, the Laboratory Manager must perform the tasks to comply with the project's analysis plan.

5.2.5.5 Third Party Performance Sample Report

Results of analysis of third party performance samples must be reviewed by the laboratory QA coordinator and a summary report prepared, before the results can be forwarded to the third party.

5.2.5.6 A Non-Compliance Report

Any non-compliance with the WESTON QA system, plans, or protocols observed by the QA coordinator will be reported at the earliest possible time, in writing, to the laboratory manager. If the situation has been corrected within 48 hours then the written report will be filed by the QA coordinator. However, if the situation is not corrected within 48 hours then the following action is required:

- The laboratory QA coordinator and the laboratory manager must submit to QA/QC Director of Programs, a corrective action plan.

Corrective action plan shall include the following information:

- Description of the non-compliance situation.
- Detailed Action Plan
- Milestones with projected completion dates.
- Estimated cost and/or loss of revenue associated with the action plan.
- If the QA/QC Director of Programs approves the action plan, necessary action will be carried out by the laboratory manager and monitored by the QA coordinator.
- If agreement on an appropriate action plan cannot be reached, the Director of QA/QC Programs will make the final determination of the actions to be taken.

5.2.5.7 WESTON Analytical Laboratory QA/QC Manual

The laboratory technical staff, the QA Coordinator, and the Director of QA/QC Programs are responsible for reviewing the WESTON Analytical Laboratory QA/QC Manual on an annual basis. This will include the WESTON Standard QA/QC Plan and the WESTON Standard Analytical Plan.

6.0 SUBCONTRACTED ANALYSES

All subcontracted analyses will be sent to a WESTON "approved" laboratory. The criteria for the WESTON approved laboratory are:

- Evidence of required regulatory authority approval/certification as appropriate.
- WESTON Analytics on-site inspection and recommendation.
- Review and evaluation of work quality

A copy of the following documents must accompany the sample(s).

- Chain of Custody forms
- WESTON analytical laboratory services agreement including conditions and appropriate attachments
- WESTON SOP for the analytical procedures(s)

The WESTON laboratory manager is responsible for all of the required documentation that must accompany any subcontracted work. The WESTON laboratory manager or designee has the "right of first refusal" of all analytical work generated by WESTON personnel. If the work is refused, the laboratory manager will take responsibility for subcontracting the work to an acceptable laboratory and will ensure compliance with the WESTON Standard QA/QC Plan, WESTON Standard Analytical Plan, WESTON Analytical Laboratory QA/QC Manual and the WESTON project's analysis plan.

APPENDIX I

LABORATORY ANALYTICAL REPORTS

ERRATA

AD-A 227 652

Pages I-1 - I-38 are not available per the
originator of this document.

DTIC-FDAC
23 Jan 91

RFW No. 8412-992-D.I. Spike

RFW

Contractor

Contract No.

OTIS

D.I.
Blank

D.I. Spike

[illegible]

ASTERISKED VALUES ARE OUTSIDE QC LIMITS.

RPD: VOAs _____ out of _____; outside QC limits
 B/N _____ out of _____; outside QC limits
 ACID _____ out of _____; outside QC limits
 PEST _____ out of _____; outside QC limits

RECOVERY:

VOAs out of ;
B/N 1 out of 7;
ACID 0 out of 5;
PEST out of ;

outside QC limits
outside QC limits
outside QC limits
outside QC limits

Comments: Surrogates: 2-Fluorophenol: 65.2%
d₅-Nitrobenzene: 46.9%

DATA SUMMARY FOR: OTIS AIR NATIONAL GUARD BASE
 DATE SAMPLES COLLECTED: 13 Dec. 1984
 RFW NO.: 8412-992-0010
 SAMPLE DESCRIPTION: Header #12

DATE EXTRACTED: 26 Dec. 1984
 DATE ANALYZED: 29 Jan. 1985

GC/MS FRACTION
 BASE/NEUTRAL COMPOUNDS

Units of Concentration ug/L				x
				mg/L
				Other
Dilution = 10%				
				Detection Limit = 200 µg/L
				Detection Limit for Benzidine(only)=2000µg
Acenaphthene	N.F.	Diethyl Phthalate	N.F.	
Acenaphthylene	N.F.	Dimethyl Phthalate	N.F.	
Anthracene	N.F.	Di-N-Butyl Phthalate	N.F.	
Benzidine	N.F.	2,4 Dinitrotoluene	N.F.	
Benzo (a) Anthracene	N.F.	2,6 Dinitrotoluene	N.F.	
Benzo (a) Pyrene	N.F.	Di-N-Octyl Phthalate	N.F.	
3,4 Benzo-fluoranthene	N.F.	1,2 Diphenyl hydrazine	N.F.	
Benzo (ghi) Perylene	N.F.	Fluoranthene	N.F.	
Benzo (k) fluoranthene	N.F.	Fluorene	N.F.	
Bis (2-chloroethoxy) Methane	N.F.	Hexachlorobenzene	N.F.	
Bis (2-chloroethyl) ether	N.F.	Hexachlorobutadiene	N.F.	
Bis (2-chloroisopropyl) ether	N.F.	Hexachlorocyclopentadiene	N.F.	
Bis (2-ethyl hexyl) phthalate	1,300	Hexachloroethane	N.F.	
4 Bromophenyl phenyl ether	N.F.	Indeno (1,2,3-cd) Pyrene	N.F.	
Butyl Benzyl phthalate	1,300	Isophorone	N.F.	
2-Chloronaphthalene	N.F.	Naphthalene	N.F.	
4-Chlorophenyl phenyl ether	N.F.	Nitrobenzene	N.F.	
Chrysene	N.F.	N-Nitrosodimethylamine	N.F.	
Dibenzo (a,h) Anthracene	N.F.	N-Nitroso di-N-propylamine	N.F.	
1,2 Dichlorobenzene	N.F.	N-Nitrosodiphenylamine	N.F.	
1,3 Dichlorobenzene	N.F.	Phenanthrene	N.F.	
1,4 Dichlorobenzene	N.F.	Pyrene	N.F.	
3,3' Dichlorobenzidine	N.F.	1,2,4 Trichlorobenzene	N.F.	
Other 2-Methylnapthalene				260
N.F. = Not Found (concentrations below detection limits)				

Surrogate Recoveries

2-Fluorophenol	72
Nitrobenzene-d5	104

I-40

Approved By:

Earl M. Hansen
 Earl M. Hansen, Ph.D.
 Director, WESTON Analytical Labs

Date of Report: 31 January 1985

DATA SUMMARY FOR: OTIS AIR NATIONAL GUARD BASE

DATE SAMPLES COLLECTED: 13 Dec. 1984

DATE EXTRACTED: 26 Dec. 1984

RFW NO.: 8412-992-0010

DATE ANALYZED: 29 Jan. 1985

SAMPLE DESCRIPTION: Header #12

GC/MS FRACTION
ACID COMPOUNDS

Units of Concentration ug/L x
mg/L
Other

Detection Limit = 200 ug/L

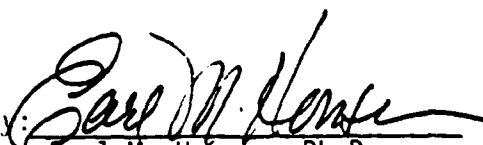
Dilution = 10%

2 Chlorophenol	N.F.
2,4 Dichlorophenol	N.F.
2,4 Dimethylphenol	20<x<200
4,6 Dinitro-0-Cresol	N.F.
2,4 Dinitrophenol	N.F.
2 Nitrophenol	N.F.
4 Nitrophenol	N.F.
P Chloro-M-Cresol	N.F.
Pentachlorophenol	N.F.
Phenol	780
2,4,6 Trichlorophenol	N.F.
Other	
2-Methylphenol	610
4-Methylphenol	930

N.F. = Not Found (concentrations below detection limits)

Surrogate Recoveries: %
2-Fluorophenol 72
Nitrobenzene-d₅ 104

Approved By:


Earl M. Hansen, Ph.D.
Director
WESTON Analytical Labs

Date of Report: 31 January 1985

DATA SUMMARY FOR: OTIS AIR NATIONAL GUARD BASE
 DATE SAMPLES COLLECTED: 13 Dec. 1984 DATE OF EXTRACTION: Not Extracted
 RFW NO.: 8412-992-0020 DATE OF ANALYSIS: 30 January 1985
 SAMPLE DESCRIPTION: Header #7

GC/MS FRACTION
 BASE/NEUTRAL COMPOUNDS

Units of Concentration ug/L x
 mg/L
 Other
 Detection Limit = 10,000 ug/L

Acenaphthene	N.F.	Diethyl Phthalate	N.F.
Acenaphthylene	N.F.	Dimethyl Phthalate	N.F.
Anthracene	N.F.	Di-N-Butyl Phthalate	N.F.
Benzidine	N.F.	2,4 Dinitrotoluene	N.F.
Benzo (a) Anthracene	N.F.	2,6 Dinitrotoluene	N.F.
Benzo (a) Pyrene	N.F.	Di-N-Octyl Phthalate	N.F.
3,4 Benzo-fluoranthene	N.F.	1,2 Diphenyl hydrazine	N.F.
Benzo (ghi) Perylene	N.F.	Fluoranthene	N.F.
Benzo (k) fluoranthene	N.F.	Fluorene	N.F.
Bis (2-chloroethoxy) Methane	N.F.	Hexachlorobenzene	N.F.
Bis (2-chloroethyl) ether	N.F.	Hexachlorobutadiene	N.F.
Bis (2-chloroisopropyl) ether	N.F.	Hexachlorocyclopentadiene	N.F.
Bis (2-ethyl hexyl) phthalate	N.F.	Hexachloroethane	N.F.
4 Bromophenyl phenyl ether	N.F.	Indeno (1,2,3-cd) Pyrene	N.F.
Butyl Benzyl phthalate	N.F.	Isophorone	N.F.
2-Chloronaphthalene	N.F.	Naphthalene	1,000 < x < 10,000
4-Chlorophenyl phenyl ether	N.F.	Nitrobenzene	N.F.
Chrysene	N.F.	N-Nitrosodimethylamine	N.F.
Dibenzo (a,h) Anthracene	N.F.	N-Nitroso di-N-propylamine	N.F.
1,2 Dichlorobenzene	N.F.	N-Nitrosodiphenylamine	N.F.
1,3 Dichlorobenzene	N.F.	Phenanthrene	N.F.
1,4 Dichlorobenzene	N.F.	Pyrene	N.F.
3,3' Dichlorobenzidine	N.F.	1,2,4 Trichlorobenzene	N.F.
		Other 2-Methylnapthalene	14,000

N.F. = Not Found (concentrations below detection limits)

No Surrogates

Approved By: 

I-42

Earl M. Hansen, Ph.D.
 Director, WESTON Analytical Labs

Date of Report: 31 January 1985

DATA SUMMARY FOR: OTIS AIR NATIONAL GUARD BASE

DATE SAMPLES COLLECTED: 13 Dec. 1984

DATE OF EXTRACTION: NOT EXTRACTED

RFW NO.: 8412-992-0020

DATE OF ANALYSIS: 30 Jan. 1985

SAMPLE DESCRIPTION: Header #7

GC/MS FRACTION
ACID COMPOUNDS

Units of Concentration ug/L x
mg/L
Other

Detection Limit: 10,000 µg/L

Dilution = 0.1%

2 Chlorophenol	<u>N.F.</u>
2,4 Dichlorophenol	<u>N.F.</u>
2,4 Dimethylphenol	<u>N.F.</u>
4,6 Dinitro-0-Cresol	<u>N.F.</u>
2,4 Dinitrophenol	<u>N.F.</u>
2 Nitrophenol	<u>N.F.</u>
4 Nitrophenol	<u>N.F.</u>
P Chloro-M-Cresol	<u>N.F.</u>
Pentachlorophenol	<u>N.F.</u>
Phenol	<u>N.F.</u>
2,4,6 Trichlorophenol	<u>N.F.</u>
Other	<u>N.F.</u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>

N.F. = Not Found (concentrations below detection limits)

No Surrogates

Approved By: Earl M. Hansen

Earl M. Hansen, Ph.D.
Director
WESTON Analytical Labs

DATA SUMMARY FOR: OTIS AIR NATIONAL GUARD BASE
 DATE SAMPLES COLLECTED: 13 Dec. 1984
 RFW NO.: 8412-992/
 SAMPLE DESCRIPTION: D.I. Blank

DATE EXTRACTED: 26 Dec. 1984
 DATE ANALYZED: 29 Jan. 1985

GC/MS FRACTION
 BASE/NEUTRAL COMPOUNDS

Units of Concentration $\mu\text{g/L}$ \times
 mg/L
 Other

Detection Limit = 200 $\mu\text{g/L}$
 Detection Limit for Benzidine (only) = 2000 $\mu\text{g/L}$

Acenaphthene	N.F.	Diethyl Phthalate	N.F.
Acenaphthylene	N.F.	Dimethyl Phthalate	N.F.
Anthracene	N.F.	Di-N-Butyl Phthalate	N.F.
Benzidine	N.F.	2,4 Dinitrotoluene	N.F.
Benzo (a) Anthracene	N.F.	2,6 Dinitrotoluene	N.F.
Benzo (a) Pyrene	N.F.	Di-N-Octyl Phthalate	86
3,4 Benzo-fluoranthene	N.F.	1,2 Diphenyl hydrazine	N.F.
Benzo (ghi) Perylene	N.F.	Fluoranthene	N.F.
Benzo (k) fluoranthene	N.F.	Fluorene	N.F.
Bis (2-chloroethoxy) Methane	N.F.	Hexachlorobenzene	N.F.
Bis (2-chloroethyl) ether	N.F.	Hexachlorobutadiene	N.F.
Bis (2-chloroisopropyl) ether	N.F.	Hexachlorocyclopentadiene	N.F.
Bis (2-ethyl hexyl) phthalate	N.F.	Hexachloroethane	N.F.
4 Bromophenyl phenyl ether	N.F.	Indeno (1,2,3-cd) Pyrene	N.F.
Butyl Benzyl phthalate	N.F.	Isophorone	N.F.
2-Chloronaphthalene	N.F.	Naphthalene	N.F.
4-Chlorophenyl phenyl ether	N.F.	Nitrobenzene	N.F.
Chrysene	N.F.	N-Nitrosodimethylamine	N.F.
Dibenzo (a,h) Anthracene	N.F.	N-Nitroso di-N-propylamine	N.F.
1,2 Dichlorobenzene	N.F.	N-Nitrosodiphenylamine	N.F.
1,3 Dichlorobenzene	N.F.	Phenanthrene	N.F.
1,4 Dichlorobenzene	N.F.	Pyrene	N.F.
3,3' Dichlorobenzidine	N.F.	1,2,4 Trichlorobenzene	N.F.
		Other	N.F.

N.F. = Not Found (concentrations below detection limits)

Surrogate Recoveries
 2-Fluorophenol 100
 d₅-Nitrobenzene 63

Approved By:

Earl M. Hansen, Ph.D.
 Director, WESTON Analytical Labs

Date of Report: 31 January 1985

DATA SUMMARY FOR: OTIS AIR NATIONAL GUARD BASE
DATE SAMPLES COLLECTED: 13 Dec. 1984 DATE EXTRACTED: 26 Dec. 1984
RFW NO.: 8412-992/ DATE ANALYZED: 29 Jan. 1985
SAMPLE DESCRIPTION: D.I. Blank

GC/MS FRACTION
ACID COMPOUNDS

Units of Concentration ug/L x
mg/L
Other
Detection Limit = 20 ug/L

2 Chlorophenol	<u>N.F.</u>
2,4 Dichlorophenol	<u>N.F.</u>
2,4 Dimethylphenol	<u>N.F.</u>
4,6 Dinitro-O-Cresol	<u>N.F.</u>
2,4 Dinitrophenol	<u>N.F.</u>
2 Nitrophenol	<u>N.F.</u>
4 Nitrophenol	<u>N.F.</u>
P Chloro-M-Cresol	<u>N.F.</u>
Pentachlorophenol	<u>N.F.</u>
Phenol	<u>N.F.</u>
2,4,6 Trichlorophenol	<u>N.F.</u>
Other	<u>N.F.</u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>
<u> </u>	<u> </u>

N.F. = Not Found (concentrations below detection limits)

Surrogate Recoveries	%
2-Fluorophenol	100
d5-Nitrobenzene	63

Approved By: Earl M. Hansen

Earl M. Hansen, Ph D.
Director
WESTON Analytical Labs

inter-office memorandum

TO: Judith Porta

DATE: 28 January 1985

FROM: Carter Nulton

SUBJECT: OTIS AFB SAMPLES
RFW#'s 8412-992-0010 - 0070
(CLIENT I.D. S-1 to S-7)

W. O. No.:

Sample 0010 was extracted with hexane and analyzed by capillary column GC/FID (30 meter DB-5); samples 0020 - 0070 were diluted 1:100 in hexane and analyzed using the same conditions. The resulting GC profiles of 0010 and 0020 were compared to those obtained from the pure products and the following observations are made:

1. 0010 - is similar to 0050 (see Fig. 1) except that the "high ends" (peaks at retention times 61.34, 63.59, 69.67, 77.29 and 84.16 on Fig. 1-4) in 0010 are of lower concentration than in 0050. The concentration of 0010 calculated on the basis of selected lower molecular weight peaks (A-E on Fig. 1) is 480 mg/L. If the "high ends" are used, the concentration is 20 mg/L.
2. 0020 - is similar to 0050 (see Fig. 2) except that the lower molecular weight peaks (those eluting between the solvent and 50 minutes) are gone.

Sample 0020 is completely miscible in hexane.

CN:bwm

Fig. 1A - Sample 0010

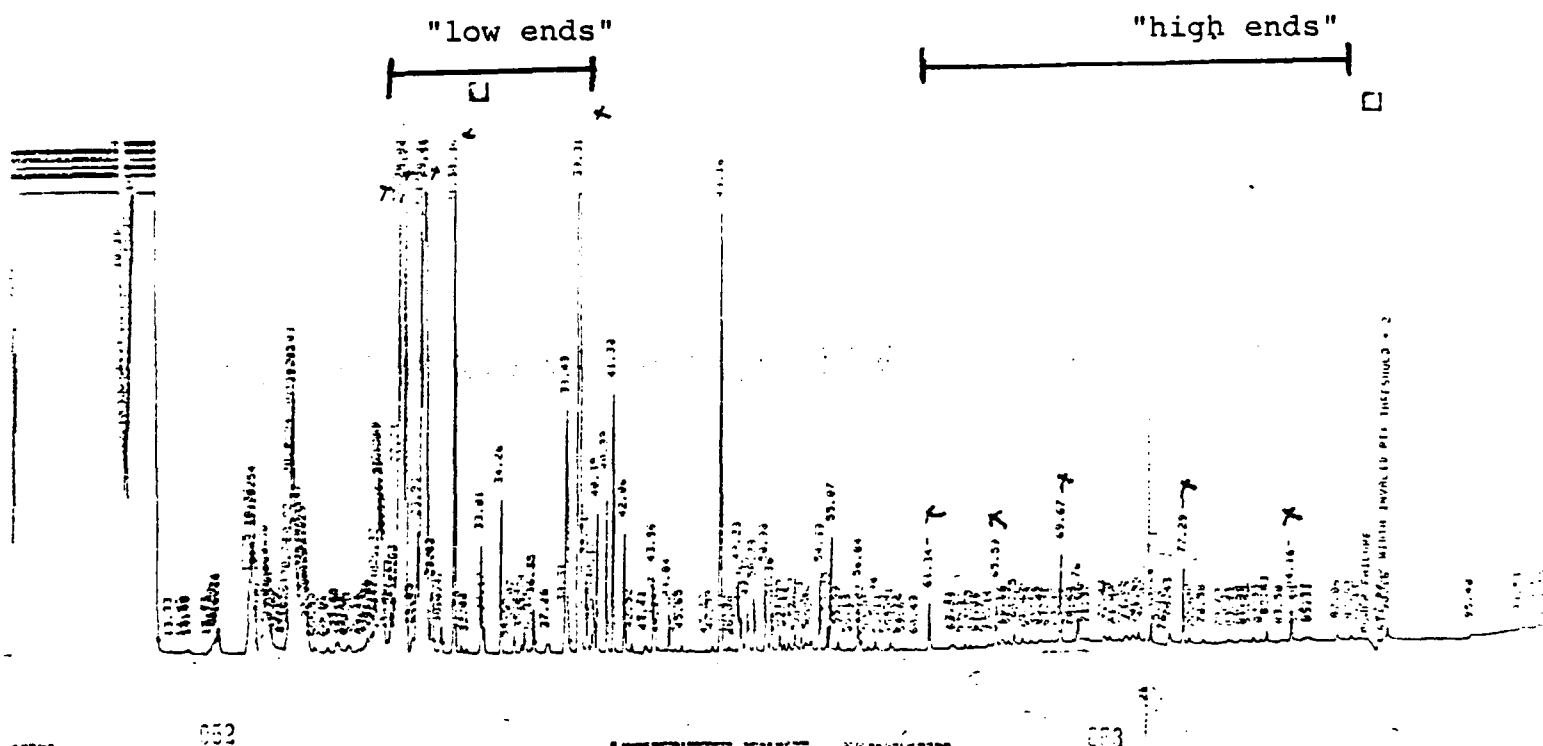


Fig. 1B - Sample 0050

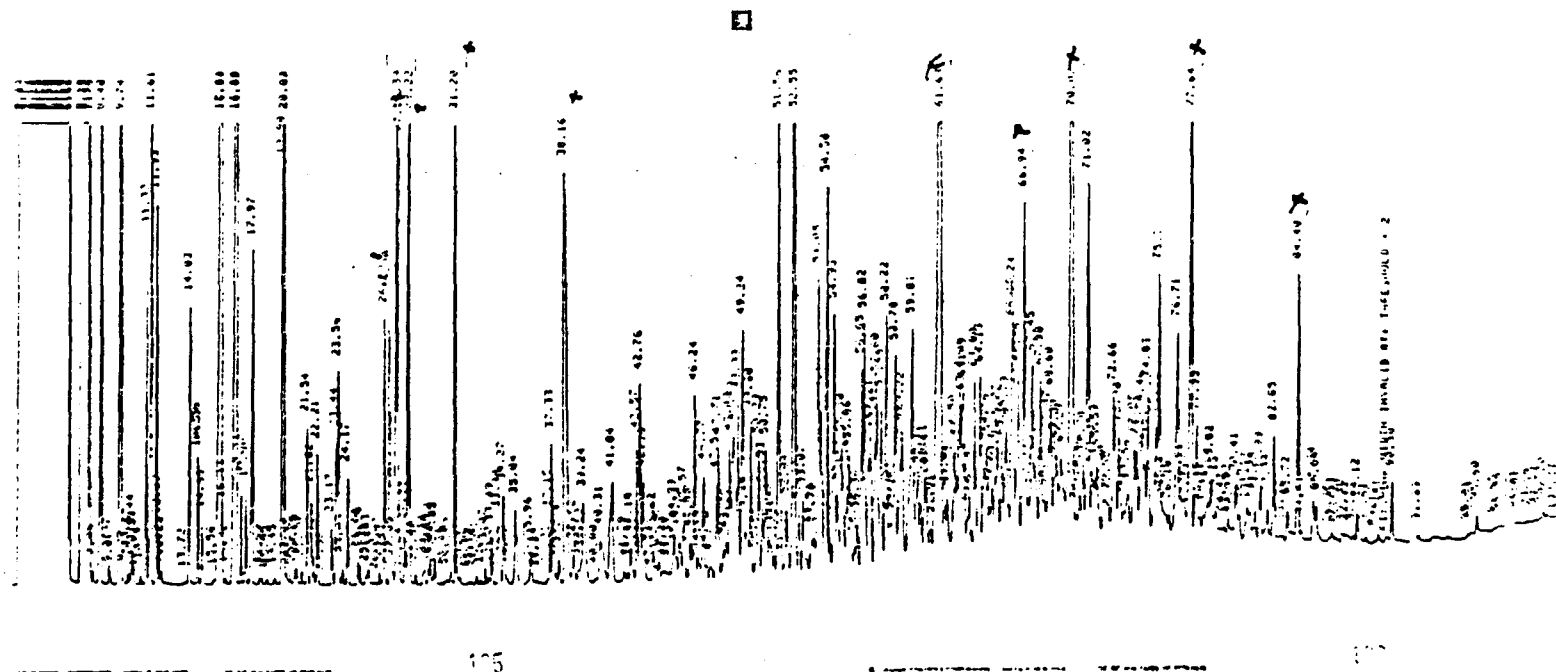


Fig. 2A - Sample 0020

"high ends"

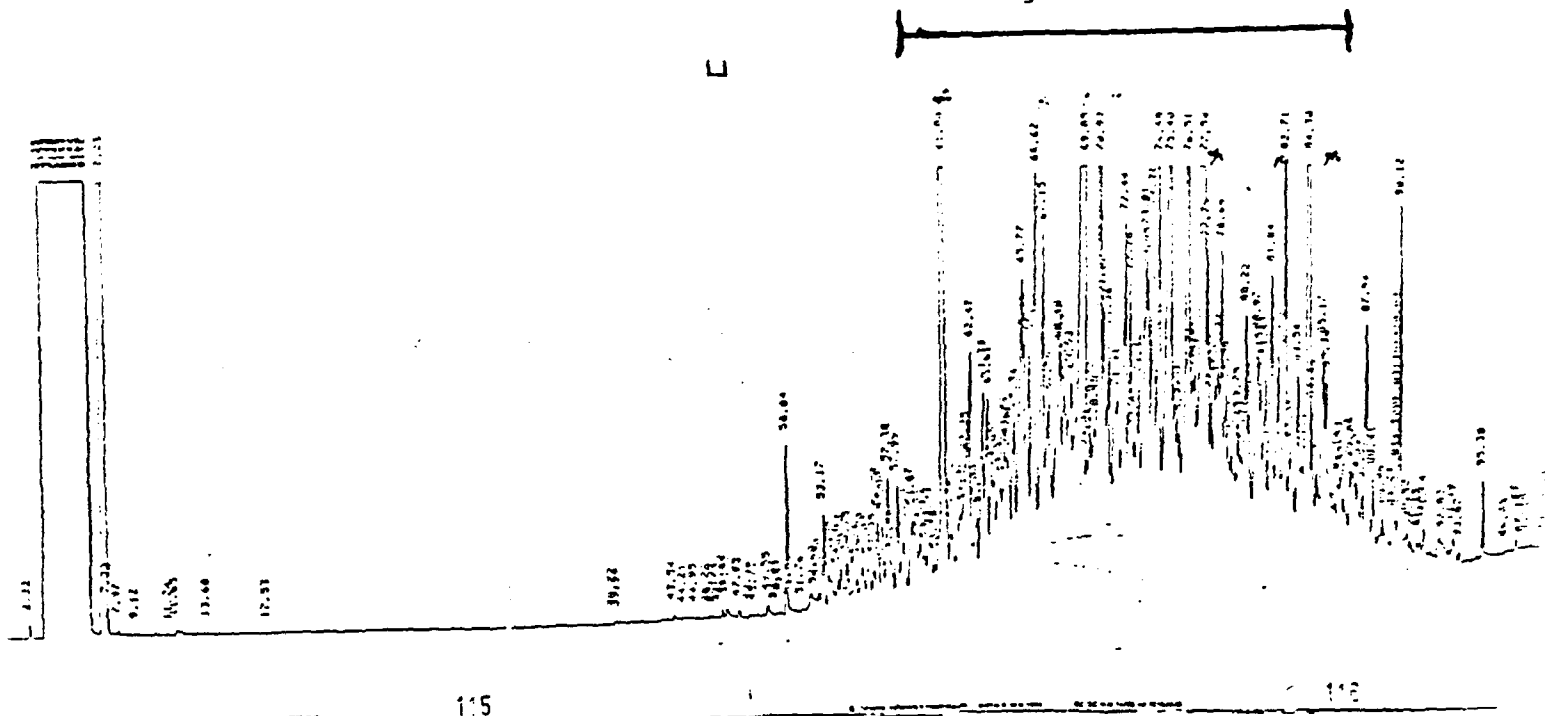
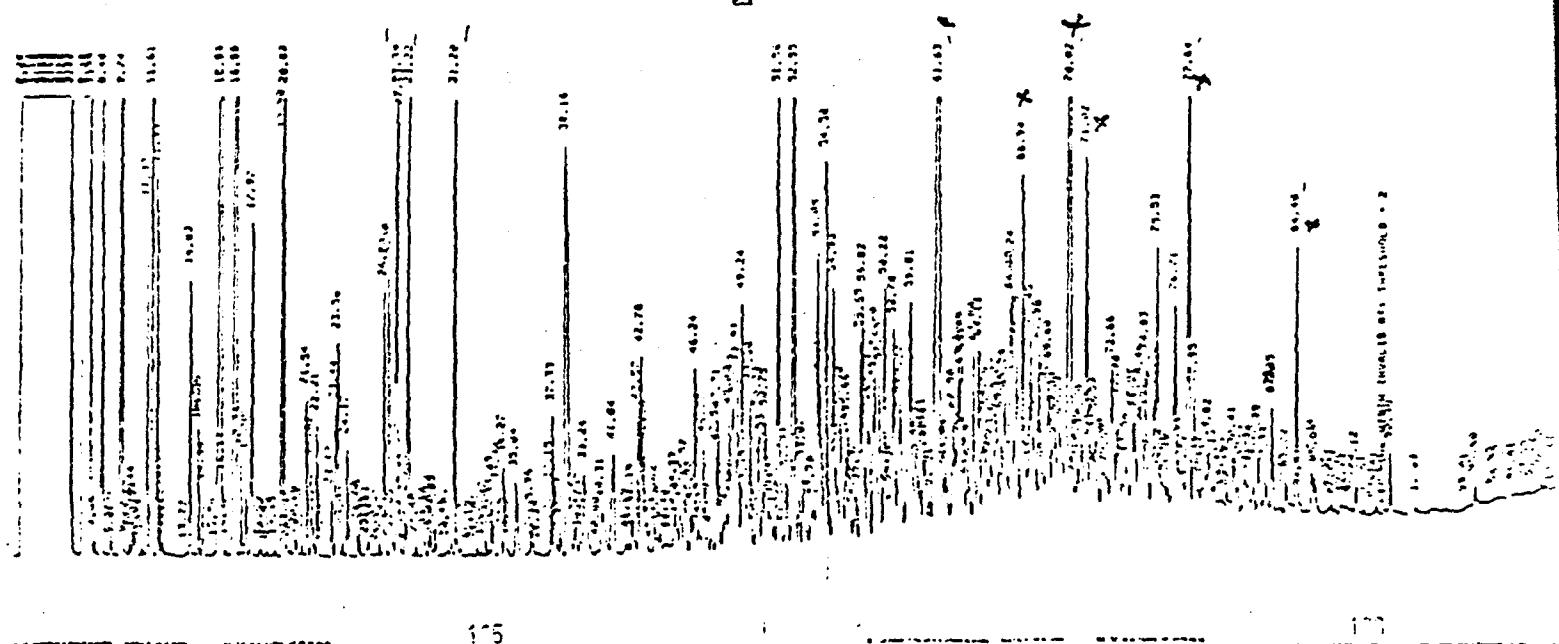


Fig. 2B - Sample 0050



23 January 1985

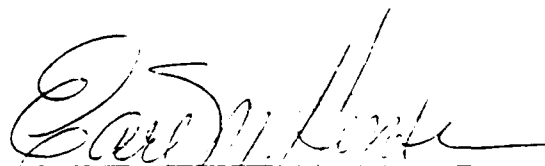
WESTON

OTIS A.N.G.
FINAL REPORT-THC
SAMPLES SUBMITTED: 5 OCT. 1984
W.O. NO.: 0628-09-28

R.F.W. NO.	SAMPLE DESCRIPTION	TOTAL FUEL HYDROCARBONS, mg/Kg
8410-712-0010	TP1	<1
-0020	TP9	<1
-0030	TP14	<1
-0040	TP16	<1
-0050	TP3A	<1
-0060	TP6A	<1
-0070	TP7A	<1
-0080	TP-8A	<1

NOTE: The method used to determine the presence of hydrocarbons in these soils was extraction of a 1 gm. sample with hexane, then analysis by FID-GC with a 30 meter fused silica capillary column.

Approved By:



Earl M. Hansen, Ph.D.
Director
Analytical Lab

RECEIVED

Date of Report: 23 January 1985

JAN 23 1985

WESTON

ROY F. WESTON, INC.
CONCORD OFFICE

OTIS A.N.G.
SUMMARY THC REPORT
SAMPLES SUBMITTED: 30 NOV. 1984
W.O. NO. 0628-05-23

<u>R.F.W. NO.</u>	<u>SAMPLE DESCRIPTION</u>	<u>TOTAL FUEL HYDROCARBONS, mg/L</u>
8411-829-0080	Well 8	<1
-0090	Well 9	<1
-0100	Well 10	<1
-0110	Well 10A	<1
-0120	Well 11	<1

NOTE: The method used to determine the presence of hydrocarbons was by FID-GC with a 30 meter fused silica capillary column.

Approved By:



Earl M. Hansen, Ph.D.
Director
Analytical Lab

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.: 8411-829/

SAMPLE DESCRIPTION: Lab Blank

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	NF
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF	Xylene	NF
1,1 Dichloroethane	NF	Methyl Isobutyl Ketone	NF
1,2 Dichloroethane	NF	Methyl Ethyl Ketone	NF
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0010

SAMPLE DESCRIPTION:

Well 1

GC/MS FRACTION
VOLATILE COMPOUNDSUnits of Concentration ug/L X
mg/L
Other

Acrolein	<u>NF</u>	Methylene Chloride	<u>NF</u>
Acrylonitrile	<u>NF</u>	1,1,2,2 Tetrachloroethane	<u>NF</u>
Benzene	<u>NF</u>	Tetrachloroethylene	<u>NF</u>
Bromomethane	<u>NF</u>	Toluene	<u>NF</u>
Bromoform	<u>NF</u>	1,2 Trans Dichloroethylene	<u>NF</u>
Carbon Tetrachloride	<u>NF</u>	1,1,2 Trichloroethane	<u>NF</u>
Chlorobenzene	<u>NF</u>	1,1,1 Trichloroethane	<u>NF</u>
Chlorodibromomethane	<u>NF</u>	Trichloroethylene	<u>12</u>
Chloroethane	<u>NF</u>	Trichlorofluoromethane	<u>NF</u>
2-Chloroethylvinyl Ether	<u>NF</u>	Vinyl Chloride	<u>NF</u>
Chloroform	<u>NF</u>	Other	<u> </u>
Dichlorobromomethane	<u>NF</u>	Detection Limit = 10 ug/L	<u> </u>
Dichlorodifluoromethane	<u>NF</u>	Xylene	<u>NF</u>
1,1 Dichloroethane	<u>NF</u>	Methyl Isobutyl Ketone	<u>NF</u>
1,2 Dichloroethane	<u>NF</u>	Methyl Ethyl Ketone	<u>NF</u>
1,1 Dichloroethylene	<u>NF</u>		<u> </u>
1,2 Dichloropropane	<u>NF</u>		<u> </u>
Ethylbenzene	<u>NF</u>		
Chloromethane	<u>NF</u>		
1,3-Trans Dichloropropene	<u>NF</u>		
1,3-Cis Dichloropropene	<u>NF</u>		

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0020

SAMPLE DESCRIPTION:

Well 2-A

GC/MS FRACTION
VOLATILE COMPOUNDSUnits of Concentration ug/L X
mg/L
Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	29
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF	Xylene	NF
1,1 Dichloroethane	NF	Methyl Isobutyl Ketone	NF
1,2 Dichloroethane	NF	Methyl Ethyl Ketone	NF
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0030

SAMPLE DESCRIPTION:

Well 3-A

GC/MS FRACTION
VOLATILE COMPOUNDSUnits of Concentration ug/L X

mg/L

Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	10
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	14
Chloroethane	NF	Trichlorofluoromethane	10
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF	Xylene	NF
1,1 Dichloroethane	NF	Methyl Isobutyl Ketone	NF
1,2 Dichloroethane	NF	Methyl Ethyl Ketone	NF
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0040

SAMPLE DESCRIPTION:

Well 4

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	22
Chlorodibromomethane	NF	Trichloroethylene	13
Chloroethane	NF	Trichlorofluoromethane	10
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF	Xylene	NF
1,1 Dichloroethane	NF	Methyl Isobutyl Ketone	NF
1,2 Dichloroethane	NF	Methyl Ethyl Ketone	NF
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0050

SAMPLE DESCRIPTION:

Well 5

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	10
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	11
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF	Xylene	NF
1,1 Dichloroethane	NF	Methyl Isobutyl Ketone	NF
1,2 Dichloroethane	NF	Methyl Ethyl Ketone	NF
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0060

SAMPLE DESCRIPTION:

Well 6

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	<u>NF</u>	Methylene Chloride	<u>NF</u>
Acrylonitrile	<u>NF</u>	1,1,2,2 Tetrachloroethane	<u>NF</u>
Benzene	<u>NF</u>	Tetrachloroethylene	<u>NF</u>
Bromomethane	<u>NF</u>	Toluene	<u>NF</u>
Bromoform	<u>NF</u>	1,2 Trans Dichloroethylene	<u>NF</u>
Carbon Tetrachloride	<u>NF</u>	1,1,2 Trichloroethane	<u>NF</u>
Chlorobenzene	<u>NF</u>	1,1,1 Trichloroethane	<u>NF</u>
Chlorodibromomethane	<u>NF</u>	Trichloroethylene	<u>10</u>
Chloroethane	<u>NF</u>	Trichlorofluoromethane	<u>NF</u>
2-Chloroethylvinyl Ether	<u>NF</u>	Vinyl Chloride	<u>NF</u>
Chloroform	<u>NF</u>	Other	<u> </u>
Dichlorobromomethane	<u>NF</u>	Detection Limit = 10 ug/L	<u> </u>
Dichlorodifluoromethane	<u>NF</u>	Xylene	<u>NF</u>
1,1 Dichloroethane	<u>NF</u>	Methyl Isobutyl Ketone	<u>NF</u>
1,2 Dichloroethane	<u>NF</u>	Methyl Ethyl Ketone	<u>NF</u>
1,1 Dichloroethylene	<u>NF</u>		<u> </u>
1,2 Dichloropropane	<u>NF</u>		<u> </u>
Ethylbenzene	<u>NF</u>		
Chloromethane	<u>NF</u>		
1,3-Trans Dichloropropene	<u>NF</u>		
1,3-Cis Dichloropropene	<u>NF</u>		

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0070

SAMPLE DESCRIPTION:

Well 7

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration: ug/L X

mg/L

Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	13
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF	Xylene	NF
1,1 Dichloroethane	NF	Methyl Isobutyl Ketone	NF
1,2 Dichloroethane	NF	Methyl Ethyl Ketone	NF
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0080

SAMPLE DESCRIPTION:

Well 8

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	<u>NF</u>	Methylene Chloride	<u>NF</u>
Acrylonitrile	<u>NF</u>	1,1,2,2 Tetrachloroethane	<u>NF</u>
Benzene	<u>NF</u>	Tetrachloroethylene	<u>NF</u>
Bromomethane	<u>NF</u>	Toluene	<u>NF</u>
Bromoform	<u>NF</u>	1,2 Trans Dichloroethylene	<u>NF</u>
Carbon Tetrachloride	<u>NF</u>	1,1,2 Trichloroethane	<u>NF</u>
Chlorobenzene	<u>NF</u>	1,1,1 Trichloroethane	<u>NF</u>
Chlorodibromomethane	<u>NF</u>	Trichloroethylene	<u>12</u>
Chloroethane	<u>NF</u>	Trichlorofluoromethane	<u>NF</u>
2-Chloroethylvinyl Ether	<u>NF</u>	Vinyl Chloride	<u>NF</u>
Chloroform	<u>NF</u>	Other	<u> </u>
Dichlorobromomethane	<u>NF</u>	Detection Limit = 10 ug/L	<u> </u>
Dichlorodifluoromethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethane	<u>NF</u>	<u> </u>	<u> </u>
1,2 Dichloroethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethylene	<u>NF</u>	<u> </u>	<u> </u>
1,2 Dichloropropane	<u>NF</u>	<u> </u>	<u> </u>
Ethylbenzene	<u>NF</u>	<u> </u>	<u> </u>
Chloromethane	<u>NF</u>	<u> </u>	<u> </u>
1,3-Trans Dichloropropene	<u>NF</u>	<u> </u>	<u> </u>
1,3-Cis Dichloropropene	<u>NF</u>	<u> </u>	<u> </u>

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0090

SAMPLE DESCRIPTION:

Well 9

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X

mg/L

Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	12
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF		
1,1 Dichloroethane	NF		
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0100

SAMPLE DESCRIPTION:

Well 10

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	12
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Detection Limit = 10 ug/L	
Dichlorodifluoromethane	NF		
1,1 Dichloroethane	NF	Xylenes	66
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	13		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0110

SAMPLE DESCRIPTION:

Well 10A

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	<u>NF</u>	Methylene Chloride	<u>NF</u>
Acrylonitrile	<u>NF</u>	1,1,2,2 Tetrachloroethane	<u>NF</u>
Benzene	<u>NF</u>	Tetrachloroethylene	<u>NF</u>
Bromomethane	<u>NF</u>	Toluene	<u>NF</u>
Bromoform	<u>NF</u>	1,2 Trans Dichloroethylene	<u>NF</u>
Carbon Tetrachloride	<u>NF</u>	1,1,2 Trichloroethane	<u>NF</u>
Chlorobenzene	<u>NF</u>	1,1,1 Trichloroethane	<u>NF</u>
Chlorodibromomethane	<u>NF</u>	Trichloroethylene	<u>12</u>
Chloroethane	<u>NF</u>	Trichlorofluoromethane	<u>NF</u>
2-Chloroethylvinyl Ether	<u>NF</u>	Vinyl Chloride	<u>NF</u>
Chloroform	<u>NF</u>	Other	<u> </u>
Dichlorobromomethane	<u>NF</u>	Detection Limit = 10 ug/L	<u> </u>
Dichlorodifluoromethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethane	<u>NF</u>	Xylenes	<u>14</u>
1,2 Dichloroethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethylene	<u>NF</u>	<u> </u>	<u> </u>
1,2 Dichloropropane	<u>NF</u>	<u> </u>	<u> </u>
Ethylbenzene	<u>51</u>		
Chloromethane	<u>NF</u>		
1,3-Trans Dichloropropene	<u>NF</u>		
1,3-Cis Dichloropropene	<u>NF</u>		

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0120

SAMPLE DESCRIPTION:

Well 11

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	<u>NF</u>	Methylene Chloride	<u>NF</u>
Acrylonitrile	<u>NF</u>	1,1,2,2 Tetrachloroethane	<u>NF</u>
Benzene	<u>NF</u>	Tetrachloroethylene	<u>NF</u>
Bromomethane	<u>NF</u>	Toluene	<u>NF</u>
Bromoform	<u>NF</u>	1,2 Trans Dichloroethylene	<u>NF</u>
Carbon Tetrachloride	<u>NF</u>	1,1,2 Trichloroethane	<u>NF</u>
Chlorobenzene	<u>NF</u>	1,1,1 Trichloroethane	<u>NF</u>
Chlorodibromomethane	<u>NF</u>	Trichloroethylene	<u>12</u>
Chloroethane	<u>NF</u>	Trichlorofluoromethane	<u>NF</u>
2-Chloroethylvinyl Ether	<u>NF</u>	Vinyl Chloride	<u>NF</u>
Chloroform	<u>NF</u>	Other	<u> </u>
Dichlorobromomethane	<u>NF</u>	Detection Limit = 10 ug/L	<u> </u>
Dichlorodifluoromethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethane	<u>NF</u>	<u> </u>	<u> </u>
1,2 Dichloroethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethylene	<u>NF</u>	<u> </u>	<u> </u>
1,2 Dichloropropane	<u>NF</u>	<u> </u>	<u> </u>
Ethylbenzene	<u>NF</u>	<u> </u>	<u> </u>
Chloromethane	<u>NF</u>	<u> </u>	<u> </u>
1,3-Trans Dichloropropene	<u>NF</u>	<u> </u>	<u> </u>
1,3-Cis Dichloropropene	<u>NF</u>	<u> </u>	<u> </u>

DATE OF REPORT: 17 December 1984

DATA SUMMARY:

OTIS AFB

DATE RECEIVED: 11/10/84, ANALYZED: 12/4/84

RFW NO.:

8411-829-0130

SAMPLE DESCRIPTION:

Well 12

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	<u>NF</u>	Methylene Chloride	<u>NF</u>
Acrylonitrile	<u>NF</u>	1,1,2,2 Tetrachloroethane	<u>NF</u>
Benzene	<u>NF</u>	Tetrachloroethylene	<u>NF</u>
Bromomethane	<u>NF</u>	Toluene	<u>NF</u>
Bromoform	<u>NF</u>	1,2 Trans Dichloroethylene	<u>NF</u>
Carbon Tetrachloride	<u>NF</u>	1,1,2 Trichloroethane	<u>NF</u>
Chlorobenzene	<u>NF</u>	1,1,1 Trichloroethane	<u>NF</u>
Chlorodibromomethane	<u>NF</u>	Trichloroethylene	<u>11</u>
Chloroethane	<u>NF</u>	Trichlorofluoromethane	<u>NF</u>
2-Chloroethylvinyl Ether	<u>NF</u>	Vinyl Chloride	<u>NF</u>
Chloroform	<u>NF</u>	Other	<u> </u>
Dichlorobromomethane	<u>NF</u>	Detection Limit = 10 ug/L	<u> </u>
Dichlorodifluoromethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethane	<u>NF</u>	Acetone	<u>27</u>
1,2 Dichloroethane	<u>NF</u>	<u> </u>	<u> </u>
1,1 Dichloroethylene	<u>NF</u>	<u> </u>	<u> </u>
1,2 Dichloropropane	<u>NF</u>	<u> </u>	<u> </u>
Ethylbenzene	<u>NF</u>	<u> </u>	<u> </u>
Chloromethane	<u>NF</u>	<u> </u>	<u> </u>
1,3-Trans Dichloropropene	<u>NF</u>	<u> </u>	<u> </u>
1,3-Cis Dichloropropene	<u>NF</u>	<u> </u>	<u> </u>

DATA SUMMARY: OTIS AFB

Date of Report: 30 November, 1984

DATE: Samples Collected: 1,2 October 1984

RFW NO.: 8410-712/

SAMPLE DESCRIPTION: Lab Blank 11/9

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L X
mg/L
Other

Acrolein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	NF
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF		
Dichlorodifluoromethane	NF		
1,1 Dichloroethane	NF		
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF	Detection Limit:	10
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

WESTON

DATE INTERIM REPORT: 10 January 1985

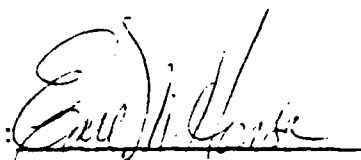
OTIS A.F.B.
INTERIM REPORT FOR
SAMPLES RECEIVED NOVEMBER 9, 1984

R.F.W. NO.	SAMPLE DESCRIPTION	HARDNESS mg/L	TOTAL Fe mg/L	SO ₄ ⁼ mg/L	CL ⁻ mg/L	NO ₃ -N mg/L	TKN mg/L	NH ₃ -N mg/L
8411-829-0010	WELL 1	25	32.6	23.1	9.0	<0.5	1.6	1.3
8411-829-0020	WELL 2-A	25	0.11	6.6	11.8	<0.5	<0.3	<0.03
8411-829-0030	WELL 3-A	34	0.15	7.9	14.7	<0.5	<0.3	<0.03
8411-829-0040	WELL 4	20	0.09	6.3	16.4	<0.5	<0.3	<0.03
8411-829-0130	WELL 12	2	0.09	<2.0	1.9	<0.5	<0.3	<0.03

R.F.W. NO.	SAMPLE DESCRIPTION	PHENOLICS mg/L	TOTAL Pb mg/L	O/G mg/L
8411-829-0080	WELL 8	<0.005	<0.01	0.16 mg/L
8411-329-0090	WELL 9	<0.005	0.022	0.13 mg/L
8411-829-0100	WELL 10	<0.005	<0.01	
8411-829-0110	WELL 10A	.006	<0.01	
8411-829-0120	WELL 11	<0.005	<0.01	
8411-829-0130	WELL 12	<0.005	NOT REQUESTED	

R.F.W. NO.	SAMPLE DESCRIPTION	PHENOLICS mg/L
8411-829-0010	WELL 1	0.007
8411-829-0020	WELL 2-A	<0.005
8411-829-0030	WELL 3-A	<0.005
8411-829-0040	WELL 4	<0.005
8411-829-0050	WELL 5	<0.005
8411-829-0060	WELL 6	<0.005
8411-829-0070	WELL 7	<0.005

APPROVED BY:


Earl M. Hansen, Ph.D.
Director
Analytical Laboratory

**Result not yet reported.

OTIS AFB

Enclosed are the data for the analysis of four soil samples from Otis AFB. Methylene chloride was detected in Sample TP-4 and TP-16 at concentrations of 1100 ug/Kg and 810 ug/Kg respectively.

Acetone was also detected in Sample TP-4 at 52 ug/Kg. Since no methylene chloride was detected in the laboratory blank, the presence of methylene chloride in these samples is not due to laboratory contamination. No other volatile compounds were detected in these samples.

DATE OF REPORT: 30 NOVEMBER 1984

DATA SUMMARY: OTIS AFB
 DATE SAMPLES COLLECTED: October 1, 2, 1984
 RFW NO.: 8410-712-0010
 SAMPLE DESCRIPTION: TP 1

GC/MS FRACTION
 VOLATILE COMPOUNDS

Units of Concentration ug/L _____
 mg/L _____
 Other ug/Kg _____

Acrolein	NF	Methylene Chloride	1 < x < 50
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	NF
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF		
Dichlorodifluoromethane	NF		
1,1 Dichloroethane	NF		
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

Detection Limit: 50

DATE OF REPORT: 30 NOVEMBER 1984

DATA SUMMARY: OTIS AFB
 DATE SAMPLES COLLECTED: October 1, 2, 1984
 RFW NO.: 8410-712-0020
 SAMPLE DESCRIPTION: TP 9

GC/MS FRACTION
 VOLATILE COMPOUNDS

Units of Concentration ug/L _____
 mg/L _____
 Other ug/Kg _____

Acrolein	NF	Methylene Chloride	1100
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	NF
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF		
Dichlorodifluoromethane	NF		
1,1 Dichloroethane	NF		
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

Detection Limit: 50

DATE OF REPORT: 30 NOVEMBER 1984

DATA SUMMARY: OTIS AFB
 DATE SAMPLES COLLECTED: October 1, 2, 1984
 RFW NO.: 8410-712-0030
 SAMPLE DESCRIPTION: TP 14

GC/MS FRACTION
 VOLATILE COMPOUNDS

Units of Concentration ug/L _____
 mg/L _____
 Other ng/Kg _____

Acrolein	NF	Methylene Chloride	1 < x < 50
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	NF
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	
Dichlorobromomethane	NF	Acetone	52
Dichlorodifluoromethane	NF		
1,1 Dichloroethane	NF		
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

Detection Limit: 50

DATE OF REPORT: 30 NOVEMBER 1984

DATA SUMMARY: OTIS AFB
 DATE SAMPLES COLLECTED: October 1, 2, 1984
 RFW NO.: 8410-712-0040
 SAMPLE DESCRIPTION: TP 16

GC/MS FRACTION
 VOLATILE COMPOUNDS

Units of Concentration ug/L _____
 mg/L _____
 Other ug/Kg _____

Acrolein	NF	Methylene Chloride	310
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	NF
Chloroethane	NF	Trichlorofluoromethane	NF
2-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	1<x<50	Other	
Dichlorobromomethane	NF	Acetone	1<x<50
Dichlorodifluoromethane	NF	2-Butanone	1<x<50
1,1 Dichloroethane	NF		
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF		
Ethylbenzene	NF	Detection Limit:	50
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		

LAB: OTIS AFB

Date of Report: 30 November, 1984

Samples Collected: 1,2 October 1984

NO.: 8410-712/

SAMPLE DESCRIPTION: Lab Blank 11/9

GC/MS FRACTION
VOLATILE COMPOUNDS

Units of Concentration ug/L _____
mg/L _____
Other ug/kg _____

Protein	NF	Methylene Chloride	NF
Acrylonitrile	NF	1,1,2,2 Tetrachloroethane	NF
Benzene	NF	Tetrachloroethylene	NF
Bromomethane	NF	Toluene	NF
Bromoform	NF	1,2 Trans Dichloroethylene	NF
Carbon Tetrachloride	NF	1,1,2 Trichloroethane	NF
Chlorobenzene	NF	1,1,1 Trichloroethane	NF
Chlorodibromomethane	NF	Trichloroethylene	NF
Chloroethane	NF	Trichlorofluoromethane	NF
1-Chloroethylvinyl Ether	NF	Vinyl Chloride	NF
Chloroform	NF	Other	NF
Dichlorobromomethane	NF		
Dichlorodifluoromethane	NF		
1,1 Dichloroethane	NF		
1,2 Dichloroethane	NF		
1,1 Dichloroethylene	NF		
1,2 Dichloropropane	NF	Detection Limit:	10
Ethylbenzene	NF		
Chloromethane	NF		
1,3-Trans Dichloropropene	NF		
1,3-Cis Dichloropropene	NF		



inter-office memorandum

TO: Dick Kraybill
cc: Les Eng
Earl Hansen

DATE: 30 November 1984

FROM: J. A. Porta

SUBJECT: INTERIM REPORT
OTIS AIR FORCE BASE

W. O. No.: 0628-09-28

Date Samples Collected: October 1984

R.F.W. NO.	CLIENT I.D.	PHENOLICS	LEAD (Pb)	UNITS
8410-712-0010	TP-1	<0.2	<12.5*	ug/g
-0020	TP-9	<0.2	28	ug/g
-0030	TP-14	0.2	38.6	ug/g
-0040	TP-16	0.3	30.9	ug/g
-0050	TP-3A	0.3	25.6	ug/g
-0060	TP-6A	0.4	24	ug/g
-0070	TP-7A	0.5	532	ug/g
-0080	TP-8A	0.2	27	ug/g

*It appears this sample does not meet required detection limits.
Please call Les Eng for confirmation.

JAP:bwm



DATES OF ANALYSES OF SAMPLES
COLLECTED OCTOBER & NOVEMBER 1984

<u>R F.W. No</u>	<u>Parameter</u>	<u>Date of Analyses</u>
8402-851-0010	O/G	2/20/84
	TOX	3/20/84
	Pb	3/20/84
	TOC	3/23/84
8410-712-0010 to 0040	VOA	11/19/84
8410-712-0010 to 0080	Phenolics	10/26/84
	Pb	10/17/84
	Total Fuel Hydro- carbons	1/10 to 1/15/85
8411-829-0010 to 0040 and 0130	Hardness	12/26/84
	Fe	11/27/84
	SO ₄ ⁻	No Record
	Cl ⁻	No Record
	NO ₃ -N	No Record
	TKN	11/21/84
	NH ₃ -N	12/3/84
8411-829-0010 to 0130	Phenolics	11/21/84
8411-829-0080 to 0130	Pb	11/27/84
8411-829-0010 to 0070,0130	O/G	1/18/85
8411-829-0080 to 0120	Total Fuel Hydro- carbon	1/10 to 1/15/85
8412-992-0010 to 0070	IP Scan	1/28/85

Date of Final Report: March 6, 1984

WESTON

OTIS A.N.G.B.
SUMMARY REPORT
FOR SAMPLES RECEIVED DECEMBER 8, 1983
W.O. NO. 0628-05-28

R.F.W. NO.	CLIENT I.D.		OIL & GREASE $\mu\text{g/g}$	TOX $\mu\text{g/g}$	TOTAL LEAD mg/Kg
		Depth			
10226	TP-11	9'	67.5	<0.1	28.6
10227	TP-10	.5-1.5	2890	0.11	93
10228	TP-10	7	202	<0.1	21
10229	TP-10	2.5-3.5	58.0	<0.1	14
10230	TP-22	1-1.5	139	.46	30
10231	TP-26	2	1660	.23	6880
10233	TP-21	.5-1	313	.64	110
10234	TP-14	4	99.5	<0.1	28
10235	TP-13	4	21.5	<0.1	37
10236	TP-12	8.5	77.5	<0.1	84
10237	TP-33	5.5	135	<0.1	280
10238	TP-12	3.5	36.6	<0.1	14
10239	TP-11	0-2.5	18200	.35	94
10240	TP-11	4	285	<0.1	18

Sample collected

11/30-12/1/83

W-101

DATA SUMMARY FOR:

OTIS AFB

DATE COLLECTED:

7-9 February 1984

RFW SAMPLE NO:

822-0010

822-0020

822-0030

822-0040

SAMPLE DESCRIPTION:

MW-1

MW-1D

MW-2A

MW-3A

ANALYSIS:

Oil/Grease, mg/L	1.03	2.85	0.15	2.00
Pesticides, mg/L	NF	NF	NF	NF
Ni, mg/L	NF	NF	NF	NF
As, mg/L	NF	NF	NF	NF
Pb, mg/L	NF	NF	NF	NF
Cr, mg/L	NF	NF	NF	NF
Cd, mg/L	NF	NF	NF	NF
Cu, mg/L	0.08	0.10	NF	0.04
Fe, mg/L	67.8	63.3	NF	NF
Cyanide, mg/L	NF	NF	NF	NF
TOX, ug/L	16.4	15.0	29.4	15.2
TOC, mg/L	57.2	57.3	59.7	31.2
PCB, ug/L	NF	NF	NF	NF
Phenol, mg/L	NF	NF	NF	NF

DATA SUMMARY FOR:

OTIS AFB

Samples Collected 7-9 February 1984

RFW SAMPLE NO:

822-0050

822-0060

822-0070

822-0080

SAMPLE DESCRIPTION:

MW-4

MW-B

Well 5

Well 5D

ANALYSIS:

Oil/Grease, mg/L

0.24

0.23

2.29

1.70

Pesticides, mg/L

NF

NF

Ni, mg/L

NF

NF

As, mg/L

NF

NF

Pb, mg/L

NF

NF

NF

NF

Cr, mg/L

NF

NF

Cd, mg/L

NF

NF

Cu, mg/L

0.04

0.04

Fe, mg/L

NF

NF

Cyanide, mg/L

NF

NF

TOX, ug/L

7.6

NF

209.2

200.2

TOC, mg/L

14.7

6.82

18.5

18.4

PCB, ug/L

NF

NF

NF

NF

Phenol, mg/L

NF

NF

RFW SAMPLE NO:

822-0090

822-0100

SAMPLE DESCRIPTION:

MW-6

Well 7

ANALYSIS:

Oil/Grease, mg/L

0.26

2.09

Pb, mg/L

NF

NF

TOX, ug/L

NF

NF

TOC, mg/L

7.8

18.2

PCB, ug/L

NF

DATA SUMMARY FOR:

OTIS AFB

DETECTION LIMITS

Pesticides

Toxaphene = 0.0048 mg/L
Lindane = 0.00028 mg/L
Endrin = 0.00040 mg/L
Methoxychlor = 0.0013 mg/L

Ni = 0.1 mg/L
As = 0.010 mg/L
Pb = 0.010 mg/L
Cr = 0.05 mg/L
Cd = 0.010 mg/L
Cu = 0.03 mg/L
Fe = 0.05 mg/L

Cyanide = 0.03 mg/L

TOX = 5 ug/L

TOC = 1 mg/L

PCB = 1.0 ug/L

Phenol = 0.005 mg/L

WESTON

DATA SUMMARY FOR:

OTIS AFB

DATE COLLECTED:

7-9 February 1984

RFW SAMPLE NO.	SAMPLE DESCRIPTION	2,4D ug/L *	2,4,5TP ug/L*	2,4,5T ug/L
802-0010	MW-1	< 50	< 10	< 10
802-0020	MW-1D	< 5	< 1	< 1
802-0030	MW-2A	< 50	< 10	< 10
802-0040	MW-3A	< 5	< 1	< 1
802-0050	MW-4	< 5	< 1	< 1
802-0060	MW-B	< 5	< 1	< 1

* There are different detection limits due to different sample volumes.

DATA SUMMARY FOR:

OTIS AFB

RFW SAMPLE NO:

851-0010

SAMPLE DESCRIPTION:

Sludge Water

ANALYSIS:

Oil/Grease, mg/L

0.92

TOX, ug/L

175

Pb, ug/L

19.5

TOC, mg/L

14.4

DATA SUMMARY FOR: OTIS AFB

RFW SAMPLE NO: 822-0120

SAMPLE DESCRIPTION: Sludge

ANALYSIS:

Oil/Grease (wet Basis), ug/g 43,800

TOX, ug/g 42.88

Pb, mg/kg 333

DATES OF ANALYSES OF SAMPLES
COLLECTED FEBRUARY 1984

<u>R F.W. No</u>	<u>Parameter</u>	<u>Date of Analyses</u>
822-0010 to 0100	Oil and Grease	3/5/84
	TOX	3/21/84
	Phenol	3/2/84
822-0010 to 0060	Pesticide/PCB	3/2/84
	Cyanide	3/22/84
	Metals	3/6/84 to 4/23/84
	Phenol	3/2/84
822-0120	Oil and Grease	3/5/84
	TOX	3/21/84
	Pb	3/15/84
851-0010	Oil and Grease	2/20/84
	TOX	3/20/84
	Pb	8/24/84
	TOC	3/23/84

DATA SUMMARY SHEET

TO:

1/11/24
3/21/24

Date(s) Samples Collected 2/1

W.O/P.O. No. _____

Client ATIS AFS

RFW No.	B.S. RFW #	Sample Description	100ppb										5ppb/mg/L			
			As	Cr	Pb	Cd	Co	Fe	Cu	Mn	Zn	TOC				
	842-523-0010	MW-1	UF	UF	UF	UF	UF	UF	0.08	67.8	10.4	57.2	UF			
	20	MW-1D	UF	UF	UF	UF	UF	UF	0.10	63.3	15.0	57.3	UF			
	30	MW-2A	UF	UF	UF	UF	UF	UF	UF	UF	29.4	59.4	UF			
	40	MW-3A	UF	UF	UF	UF	UF	UF	0.04	UF	15.2	31.2	UF			
	50	MW-4	UF	UF	UF	UF	UF	UF	0.04	UF	7.6	14.7	UF			
	60	MW-5	UF	UF	UF	UF	UF	UF	0.04	UF	UF	6.82	UF			
	70	MW-5	UF	UF	UF	UF	UF	UF	UF	UF	209	18.5	UF			
	80	MW-5D	UF	UF	UF	UF	UF	UF	UF	UF	200	18.4	UF			
	90	MW-6	UF	UF	UF	UF	UF	UF	UF	UF	UF	7.8	UF			
	100	MW-7	UF	UF	UF	UF	UF	UF	UF	UF	UF	18.2	UF			
	110		UF	UF	UF	UF	UF	UF	UF	UF	UF	UF	UF			
	0130	Blank	UF	UF	UF	UF	UF	UF	0.04	UF	UF	UF	UF			

Signed _____

Q. A. Officer

Date _____

BY _____ DATE _____ DIV _____ SHEET _____ OF _____
 CHD BY _____ DATE _____ DEPT _____ W.O. NO. _____
 PROJECT _____
 SUBJECT Testicular Sperm 3/5/70

	Testosterone	LH (0.72)	FSH (10.00)	HCG (21.14)	
933-0010 5000 + 100	NF	NF	NF	NF	1.00, 3.00, 4.05
933-0011 5000 + 100	NF	NF	NF	NF	1.50, 3.00, 4.00
933-0012 5000 + 100	NF	NF	NF	NF	4.33, 5.14
933-0040 5000 + 100	NF	NF	NF	NF	1.35, 1.70, 3.33, 4.10, 4.07
933-0050 5000 + 100	NF	NF	NF	NF	3.04, 2.92, 4.74
933-0060 5000 + 100	NF	2.74 (NF) 60.07	NF	NF	1.30, 1.79
933-0070 5000 + 100	NF	2.90 (NF) 10.07	NF	NF	1.39, 1.30, 4.71

D.L. 0.0048 ng/L 0.00028 ng/L 0.00040 ng/L 0.0013 ng/L

LH 12.58 ← 2.73 → 2.90 | 5% window

FSH 19.55 ← 10.06 → 10.56

HCG 20.02 ← 21.14 → 22.00

933-0050 has a garbage peak at 2.97

$$\frac{0.0048}{1000000} \times 0.1414 \text{ ng/L} \times \frac{1 \text{ mL}}{500 \text{ mL}} = 0.00000157 \text{ ng/L}$$

$$\frac{10.07}{1000000} \times 0.1414 \text{ ng/L} \times \frac{1 \text{ mL}}{500 \text{ mL}} = 0.00000430 \text{ ng/L}$$

Att. 297

DATA SUMMARY SHEET

Date(s) Samples Collected

W.O/P.O. No.

0715 AFB

 mg/l

09/2

UG/2

7/6/4

AFW No.

B.S. RFW #

Sample Description

22

10x

62

Try

842-851-0010

George A. Bates

0.72

175-

19.5-

七

Signed

Date _____

Q. A. Officer

SUBMITTED BY Rich Krapchik

MISC. 201 641

SAMPLE DESCRIPTION

DATE COLLECTED: 11/1/78

PA

PA

PA

PA

PA

PA

PA

PA

- 11 9'

o/c-	TOX	Pb
------	-----	----

-10 .5 - 1.5'

-10 7'

- 10 2.5 - 3.5'

-22 1-1.5"

-26 2'

-21 0.5-1.0

-14 4'

-13 4'

12	8.5	one to another bottle
22	5.5	broken transferred

-33 5.5'

-12 3.5'

- 11 0-2.5'

11/2

BY _____ DATE _____ DIV. _____ SHEET _____ OF _____
 CHKD BY _____ DATE _____ DEPT _____ W.O. NO. _____
 PROJECT _____
 SUBJECT Uris Fertilizer Screen 2/15/74

	Temperature	Linear (3.72)	Endrin (10.00)	Mathesonchlor (31.14)	
933-0010 4500 ± 100	NF	NF	NF	NF	1.00, 3.00, 4.05
933-0020 5000 ± 100	NF	NF	NF	NF	1.59, 3.42, 4.00
933-0030 5000 ± 100	NF	NF	NF	NF	4.33, 5.14
933-0040 5000 ± 100	NF	NF	NF	NF	1.35, 1.72, 3.33, 4.12, 4.67
933-0050 5000 ± 100	NF	NF	NF	NF	3.04, 2.92, 4.74
933-0060 5000 ± 100	NF	2.74 (NF) 60.07	NF	NF	1.30, 1.79
933-0070 5000 ± 100	NF	2.76 (NF) 10.07	NF	NF	1.39, 1.30, 4.71

D.L. 0.0048 ^{ng/l} 0.00028 ^{ng/l} .00040 .0013

Linear 12.58 ← 2.73 → 2.76 | 5% Window

Endrin 19.55 ← 10.00 → 10.56

Mathesonchlor 30.07 ← 31.14 → 32.30

933-0050 has a garbage peak at 3.77

$$\frac{60.07}{10807.40} \times 0.1414 \text{ } \mu\text{g/g} \times \frac{1 \text{ ml}}{500 \text{ ml}} = 0.00000157 \text{ ng/l}$$

$$\frac{10.07}{10807.40} \times 0.1414 \text{ } \mu\text{g/g} \times \frac{1 \text{ ml}}{500 \text{ ml}} = 0.000000420 \text{ ng/l}$$

Attn. 2^7

PRIORITY/HAZARD

SUBMITTED BY _____

MISC: 003

I-89

DATA SUMMARY SHEET

TO:

Date(s) Samples Collected 2/1

W.O/P.O. No.

Client OTIS AFB

RFW No.	B.S. RFW #	Sample Description	pH	100ppb							10ppb				ug/L /mg/L	
				As	Li	Bd	Pb	Cu	Cd	Fe	Cu	Fe	Cd	TOX	TOC	RB
	862-822-0010	MW-1	1.03	NF	NF	NF	NF	NF	NF	0.08	67.8	NF	NF	16.4	57.2	NF
	20	MW-12	2.85	NF	NF			NF		0.10	63.3	NF	NF	15.0	57.3	
	30	MW-2A	0.15	NF	NF			NF		NF	NF	NF	NF	29.4	59.7	
	40	MW-3A	2.00	NF	NF			NF		0.04	NF	NF	NF	15.2	31.2	
	50	MW-4	0.24	NF	NF			NF		0.04	NF	NF	NF	7.6	14.7	
	60	MW-8	0.23	NF	NF			NF		0.04	NF	NF	NF	NF	6.82	
	70	MW-5	2.29											209.2	18.5	NF
	80	MW-5B	1.70											200.2	18.4	NF
	90	MW-6	0.26											NF	7.8	NF
	100	MW-7	2.09					NF						NF	18.2	
	110							NF								
	0130	Blank		NF	NF	NF	NF	NF	NF	0.04	NF	NF	NF	NF	NF	NF

Signed

Date

Q. A. Officer

inter-office memorandum

TO: Dick Kraybill
cc: Carter Nulton
Les Eng
Earl Hansen

DATE: 29 January 1985

FROM: Judy Porta *JAP*

SUBJECT: ADD'N INFORMATION
OTIS A.N.G. BASE

W. O. No.: 0628-03-28-00

My apologies for not identifying the R.F.W. Nos. in Carter Nulton's memo of 28 January 1985. R.F.W. No. 8412-992-0010 is your S-1 (Header #12) and R.F.W. No. 8412-992-0020 is your S-2 (Header #7). R.F.W. No. 8412-992-0030 is AX Gas; -0040 is MO Gas; -0050 is JP-4; -0060 is Diesel Fuel; and -0070 is Heating Fuel.

The lead results are as follows:

R.F.W. NO.	SAMPLE DESCRIPTION	TOTAL Pb, mg/L
8412-992-0010	Header #12	29.00
8412-992-0020	Header #7	<0.50*

*Ken is re-running this sample today on the AA Furnace to achieve a lower detection limit.

Also, Carter will have the B/N/A results by tomorrow or Thursday. They were scheduled for analysis all along.

Les Eng has not given me a definite date as to when the petroleum hydrocarbon oil and grease will be completed; however, he is in the process of determining them. As soon as these results are ready, I will telecopy them to you.

JAP:bwm

inter-office memorandum

TO: Dick Kraybill

cc: Rich Johnson (memo only)
Les Eng (memo only)

DATE: 31 January 1985

FROM: Earl M. Hansen SUBJECT: ACID/BASE/NEUTRAL GC/MS FRACTIONS &
LEAD RE-ANALYSIS
SUMMARY REPORT
OTIS A.N.G.B.

W. O. No.: 0628-03-28-00

The attached are the results of analysis by EPA Method 625 for two samples submitted by you for the above-referenced client. Spike recovery information is also attached. The EPA recommended holding time of 7 days between date of collection and date of extraction for sample #8412-992-0010 was exceeded by 6 days due to the holiday season. The recommended holding time of 40 days between extraction and analysis was not exceeded. Sample #8412-992-0020 was not extracted because of the nature of the sample. Sample #8412-992-0020 was re-analyzed for lead on the AA furnace and a concentration of 36.5 µg/L was found.

As of this date I have not received any data on the petroleum hydrocarbon oil and grease analysis. As soon as these are completed, I will forward the results to you.

EMH:bwm

Attachments

APPENDIX J

FEDERAL AND STATE DRINKING WATER
AND HUMAN HEALTH STANDARDS
APPLICABLE IN THE STATE OF MASSACHUSETTS



GUIDE TO GROUND-WATER STANDARDS

OF THE UNITED STATES

API PUBLICATION 4366

JULY 1983

Prepared by
Ecological Analysts, Inc.
15 Loveton Circle
Sparks, Maryland 21152

3. FEDERAL PROTECTION OF GROUND-WATER QUALITY

The federal programs dealing with the protection of ground-water quality are administered largely by the Environmental Protection Agency (EPA). The federal programs which provide the framework for state regulations are summarized in this section.



3.1 GROUND-WATER PROTECTION POLICY

At this writing, February 1983, U.S. EPA's final policy on ground-water protection, scheduled for September 1982 release, has not been published. Based on the proposed strategy published by EPA in November 1980 and recent press releases, it appears that EPA will be implementing a policy that would give the states lead responsibility in the protection of ground-water quality. EPA's efforts apparently will be focused in three major areas:

1. Development of an internally consistent federal approach to ground-water protection
2. Monitoring, research and development efforts directed toward more comprehensive problem definition and new detection, controls, and clean-up technology development
3. Guidance, coordination, and assistance to states in the development of state policies

A significant component of EPA's policy is expected to be a ground-water classification system which could be used to determine the degree of protection needed for various types of ground water. Ground-water classification is discussed in Chapter 4.

3.2 CLEAN WATER ACT

This statute refers to ground-water protection in municipal waste water treatment, planning, and research programs. Its principal regulatory programs, however, focus on surface water. Section 303 empowers EPA to approve states' water quality standards which are based on the states' classification of rivers and streams. Many states have included ground water in their definition of "waters of the state" for purposes of this act (state summaries). On this basis the National (state) Pollutant Discharge Elimination System (NPDES/SPDES) permitting process may be invocable for purposes of ground-water protection. In addition the act empowers EPA to

1. Develop a comprehensive program for ground-water pollution control [Section 102(a)]
2. In cooperation with states, equip and maintain a surveillance system for monitoring ground-water quality [Section 104(a)(5)]
3. Provide grants to states and area-wide agencies to develop ground-water quality management plans to identify salt water intrusion and control disposal of pollutants in subsurface excavations, and control disposition of wastes. (May include authority for comprehensive ground-water management plans, including conjunctive use with surface water) [Section 102(c), 208(b)]
4. Require development of Best Management Practices (BMP) to control nonpoint source pollution problems to ground-water quality [Section 208(b)]
5. Develop criteria for ground-water quality considering kind and extent of effects on health and welfare from the presence of pollutants [Section 304(a)]
6. Determine information necessary to restore and maintain chemical, physical, and biological integrity of ground water [Section 304(a)]
7. Issue information on the factors necessary to restore and maintain chemical, physical, and biological integrity of ground water [Sections 304(a)(2)]

3.3 SAFE DRINKING WATER ACT

This statute authorizes EPA to set maximum contaminant levels (MCLs) and monitoring requirements for public water systems and provides for the protection of underground sources of drinking water. The MCLs regulate the quality of "finished" water, i.e., water as delivered, not the quality of the source water. As discussed below the MCLs have been utilized by EPA and the states as the basis for other regulations dealing with ground-water quality and protection.



3.3.1 National Interim Primary Drinking Water Regulations

EPA initiated a detailed study of the health effects of various contaminants in water soon after the Safe Drinking Water Act (SDWA) was signed into law. So that the regulations could include the findings of this and other studies, primary drinking water regulations were to be developed in two stages: an interim version and a final version. The interim version of the regulation became effective 24 June 1977. SDWA provides for delegation of authority to states. State Primary Drinking Water Regulations must be at least as stringent as the federal regulations.

The National Interim Primary Drinking Water Regulations define Maximum Contaminant Level as the maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system, except in the case of turbidity (applicable to surface water only) where the maximum permissible level is measured at the point of entry to the distribution system. The MCLs are provided with the summaries.

3.3.2 National Secondary Drinking Water Regulations

These regulations control contaminants in drinking water that primarily affect the aesthetic qualities relating to public acceptance of drinking water. At considerably higher concentrations of these contaminants, health implications may also exist as well as aesthetic degradation. The National Secondary Drinking Water Regulations are not federally enforceable but are intended as guidelines for the states.

Secondary Maximum Contaminant Levels (SMCLs) are defined as the maximum permissible level of a contaminant in water which is delivered to the free-flowing outlet of the ultimate user of a public water system. Federal and state SMCLs are provided in the state summaries. The states may establish higher or lower levels which may be appropriate depending upon local conditions such as unavailability of alternate sources of water or other compelling factors, provided the public health and welfare are not adversely affected.

3.3.3 Sole Source Aquifer

The Sole Source Aquifer provisions of SDWA allow EPA to designate an aquifer as the sole source of drinking water for an area thereby guaranteeing protection from contamination by federally assisted activities. Regional, or state agencies can petition EPA for sole source designation. The EPA Administrator may designate an aquifer which is a sole or principal drinking water source if its contamination would create a significant hazard to public health. If the designation is made, no federal money or financial commitment may be made for any activity which the Administrator determines may contaminate the designated aquifer through its recharge zone.

At this writing, February 1983, EPA has designated the following ten sole source aquifers:

Biscayne Aquifer - Florida	Nassau and Suffolk counties - New York
Buried Valley Aquifer - New Jersey	Cape Cod - Massachusetts
Edwards Aquifer - Texas	Fresno - California
Camano Island—Whidbey Island Aquifer - Washington	Ten Mile Creek - Maryland
Spokane-Rathdrum Aquifer - Washington and Idaho	Northern Guam Lens - Guam

The following eighteen are under consideration:

Arizona	New York
Santa Cruz, Upper Santa Cruz, Agua-Alta Basins	Kings and Queens counties
California	Sardinia
Scotts Valley	Schenectady
Delaware	Vestal
New Castle County	Pennsylvania
Florida	Seven Valleys
Volusia - Floridan Aquifer	Texas
Idaho	Camizo-Wilcox Aquifer
Snake River Plain	Texas and New Mexico
Louisiana	Delaware Basin
Baton Rouge	Wisconsin
DeSoto Parish	Niagara Aquifer
New Jersey	
Coastal Plain	
Ridgewood	
Upper Rockaway	

3.3.4 Underground Injection Control

The Underground Injection Control (UIC) program regulates the uses of underground injection wells to protect an underground source of drinking water (USDW). USDW means an aquifer or its portion which

1. supplies any public water system or contains a sufficient quantity of ground water to supply a public water system;
2. currently supplies drinking water for human consumption or contains less than 10,000 mg/liter total dissolved solids; and
3. is not an exempted aquifer (40 CFR 146.04 provides criteria for exemption).

SDWA requires any state designated by EPA as requiring a UIC program to develop and submit a state UIC program for EPA approval. EPA has designated each of the fifty states.

The federal program classifies injection wells as follows:

Class I—Wells used to inject hazardous waste, or other industrial and municipal disposal wells which inject fluids beneath the lower-most formation containing a USDW within one-quarter mile of the well bore.

Class II—Wells that inject fluids

1. which are brought to the surface as part of conventional oil or natural gas production and may be mixed with production waste waters from gas plants, unless those waters are classified as a hazardous waste at the time of injection;
2. for enhanced recovery of oil or natural gas; and
3. for storage of hydrocarbons which are liquid at standard temperature and pressure.

Class III—Wells that inject for extraction of minerals including

1. mining of sulfur by the Frasch process;
2. in situ production of uranium or other metals. This category includes only in situ production from ore bodies which have not been conventionally mined. Solution mining of conventional mines such as stopes leaching is included in Class V; and
3. solution mining of salts or potash.

Class IV—Wells used to dispose of hazardous or radioactive waste into or above a formation which contains a USDW within one-quarter mile of the well. Also, wells used to inject hazardous waste that cannot be classified as Class I or Class IV under the above criteria are Class IV wells.

Class V—All other injection wells (40 CFR 146.05(e) and 146.51 provide specific information and exemptions).

Underground injection is controlled through the permitting process. Construction, operation, monitoring and reporting activities are controlled. Individual state programs are based upon, and must be essentially equivalent to, the federal criteria and standards (40 CFR 146).

3.4 TOXIC SUBSTANCE CONTROL ACT

This statute (TSCA) authorizes EPA to restrict or prohibit the manufacture, distribution, and use of products which may result in unreasonable risk to health and the environment. Although ground water is not specifically named in the Act, EPA has taken the position that the protection of health and the environment includes the protection of ground water.

3.5 FEDERAL INSECTICIDE, FUNGICIDE, RODENTICIDE ACT

This statute (FIFRA) gives EPA the responsibility to control the sale and use of all pesticides to prevent unreasonable adverse environmental and health effects. The use and disposal of pesticide packages and containers is also regulated. In deciding whether to register, cancel, suspend, or change the classification of a pesticide, EPA considers a broad range of environmental impacts including those affecting ground water.





3.6 RESOURCE CONSERVATION AND RECOVERY ACT

The Solid Waste Disposal Act and the Resource Recovery Act of 1970, as amended by the Resource Conservation and Recovery Act of 1976 (RCRA), require EPA to establish a national program to regulate the management of waste materials.

3.6.1 Solid Waste

Subtitle D of RCRA established a broad-based national program to improve solid waste management through the development of state and regional solid waste management plans. The act offered federal financial assistance to states interested in developing and implementing a solid waste management plan. The state plans, under federal guidelines, identify respective responsibilities of local, state, and regional authorities, and encourage resource recovery and conservations and the application and enforcement of environmentally sound disposal practices.

A major element of the Subtitle D program is the open dump inventory. Section 4005 of RCRA prohibits open dumping. Federal criteria for classifying solid waste management facilities are provided in 40 CFR 257. EPA cannot approve a state solid waste management program with less stringent criteria. Solid waste management facilities failing to satisfy the criteria are considered open dumps. In order to satisfy these criteria, a facility or practice (in addition to other environmental considerations) shall not contaminate an underground drinking water source beyond the solid waste boundary or beyond an alternative boundary established by the state or in compliance pursuant to the stipulations of 40 CFR 257.3-4. The federal criteria define contamination as an exceedance of the MCLs provided in the National Interim Primary Drinking Water Regulations or an increase in concentration of any parameter for which the ambient concentration exceed the MCL.

3.6.2 Hazardous Waste

EPA has issued a series of hazardous waste regulations under Subtitle C of RCRA (40 CFR 260 to 267 and 122.1 to 122.124). On 19 May 1980, EPA issued a comprehensive set of standards for generators and transporters of hazardous waste and "interim status" standards for facilities in existence on 19 November 1980, that treat, store, or dispose of hazardous waste. Such facilities were allowed to operate under interim status until they received an RCRA permit. Subsequently, EPA issued standards for granting RCRA permits to treatment and storage facilities. Standards for land disposal facilities were issued on 26 July 1982—virtually completing the program for controlling hazardous waste under RCRA.

The standards for permitting land disposal facilities were issued after a wide range of regulatory options were considered. Over a period of several years, EPA proposed two different sets of land disposal standards and solicited comments on various issues. On 13 February 1981, EPA issued temporary standards for new land disposal facilities. The 26 July regulations replace those temporary standards except for Class I underground injection wells. These will remain subject to the temporary standards until final standards are issued.

The regulations consist primarily of two complementary sets of performance standards:

1. A set of design and operating standards tailored to each of four types of facilities
2. Ground-water monitoring and response regulations applicable to all land disposal facilities

The design and operating standards implement a liquids management strategy that has two goals:

1. Minimize leachate generated at the facility
2. Remove leachate generated to minimize its chance of reaching ground water

The major requirements include

1. Liner
 - Requirement: design to prevent migration of waste out of the facility during its active life
 - Applicability: landfills, surface impoundments, and waste piles
2. Leachate collection and removal
 - Requirement: collect and remove leachate from the facility and ensure that leachate depth over the liner does not exceed 30 centimeters (1 foot)
 - Applicability: landfills and waste piles



3. Run-on and runoff control systems
 - Requirement: design to control flow during at least 25-year storm
 - Applicability: landfills, waste piles, land treatment
4. Wind dispersal controls
 - Requirement: cover waste or otherwise manage unit to control wind dispersal
 - Applicability: landfills, waste piles, and land treatment units that contain particulate matter
5. Overtopping controls
 - Requirement: prevent overtopping or overfilling
 - Applicability: surface impoundments
6. Disposal unit closure
 - Requirement: final cover (cap) over waste unit designed to minimize infiltration of precipitation
 - Applicability: landfills and surface impoundments (if used for disposal)
7. Storage unit closure
 - Requirement: remove waste and decontaminate
 - Applicability: surface impoundments used for treatment or storage and waste piles
8. Postclosure Care
 - Maintain effectiveness of final cover
 - Operate leachate collection and removal system
 - Maintain ground-water monitoring system (and leak detection system where double liner is used)
 - Continue 30 years after closure

The goal of the ground-water monitoring and response program is to detect and correct any ground-water contamination. There are four main elements:

1. A detection monitoring program which requires the permittee to install a system to monitor ground water in the uppermost aquifer to determine if a leachate plume has reached the edge of the waste management area.
2. A ground-water protection standard is set when a hazardous constituent is detected. The standard specifies concentration limits, compliance point, and compliance period.
3. A compliance monitoring program determines if the facility is complying with its ground-water protection standard.
4. Corrective action is required when the ground-water protection standard is violated. The permittee must either remove the contamination or treat it in place to restore ground-water quality.

Until hazardous waste management facilities are issued permits, existing facilities will continue to operate under interim status standards. Facilities operating under interim status will be required to file Part B applications for final permits.

Under Subtitle C of RCRA, EPA approves state hazardous waste management programs in two phases. Phase I authorization gives states the right to control transportation and generation of hazardous wastes within their borders and to regulate existing treatment, storage, and disposal facilities. Phase II authorization includes the permitting of new facilities.

3.7 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT

This statute (CERCLA), commonly referred to as Superfund, authorizes EPA to respond to releases or threatened releases into the environment, including ground water, of any hazardous substance which may present an imminent and substantial danger to public health. The act provides funds for emergency action and has cost recovery provisions.



MASSACHUSETTS

Classification—Ground water is included in the definition of "Waters of the Commonwealth" as found in the Massachusetts Clean Waters Act. No ground-water classification system is currently in effect. The Water Resources Commission is investigating such a system as part of a statewide Ground-Water Management Plan.

Quality Standards—There are no ground-water standards in effect at the present; they are under consideration as part of a classification system.

Drinking Water Standards—The Department of Environmental Quality Engineering has adopted the federal primary and secondary drinking water standards.

Appropriation—The Common Law system governs ground-water allocations in Massachusetts. There are no permit requirements or limits on the amounts withdrawn by any user. A permit system is under consideration, however, for the purpose of management and protection of ground-water resources.

Controlled Use Areas—There are none at the present.

Well Construction—Public supply wells must be constructed according to standards of the Department of Environmental Quality Engineering.

Underground Injection Control—Massachusetts has developed a state UIC program that has been submitted for EPA approval. The Department of Environmental Quality Engineering will be the lead agency in the program. All injection wells except for Class V wells will not be permitted.

Waste Management Facilities—The solid and hazardous waste management programs are administered by the Department of Environmental Quality Engineering.

Solid Waste—The Massachusetts Solid Waste Regulations do not state minimum ground-water monitoring requirements. Permit requirements for siting and operation of disposal sites are such as to prevent ground-water contamination. Ground-water monitoring may be required on a case-by-case basis.

Hazardous Waste—Massachusetts has received interim status authority for RCRA Phase I and is seeking Phase II authority. The Massachusetts Hazardous Waste Regulations have incorporated EPA ground-water monitoring requirements (40 CFR 265 Subpart F) by reference.

Sole Source Aquifers—Cape Cod has been designated as such by EPA.

Geological Surveys—

Division of Waterways
Department of Environmental
Quality Engineering
One Winter Street
Boston, MA 02114
617-292-5690
State Geologist:
Mr. Joseph A. Sinnot

Water Resources Division
U.S. Geological Survey
150 Causeway St., Suite 1001
Boston, MA 02114
617-223-2822
District Chief:
I.C. James II

Note: New England District Office for Massachusetts, Maine, New Hampshire, Rhode Island, and Vermont.

References—

Massachusetts Clean Waters Act
(Mass. Gen. Laws, Chap. 21, Secs. 26-53)

Massachusetts Hazardous Waste Regulations
(CMR, Title 315, Chap. 2)

Massachusetts Solid Waste Regulations
(CMR, Title 310, Chap. 19)

Contacts—

Water Pollution Control Division
Department of Environmental
Quality Engineering
One Winter Street
Boston, MA 02108
617-292-5673

Mr. Emerson Chandler
Water Resources Commission
Department of Environmental
Management
100 Cambridge Street
Boston, MA 02202
617-727-3170

No comments on this summary were received from the Commonwealth of Massachusetts.

MASSACHUSETTS

Parameter (mg/l unless noted)	Drinking Water Standards		Quality Standards	Monitoring Requirements	
	Federal	State		Solid Waste	Hazardous Waste
Arsenic	0.05	0.05			M
Barium	1.0	1.0			M
Cadmium	0.010	0.010			M
Chromium	0.05	0.05			M
Lead	0.05	0.05			M
Mercury	0.002	0.002			M
Selenium	0.01	0.01			M
Silver	0.05	0.05			M
Fluoride	1.4-2.4	1.4-2.4			M
Nitrate (as N)	10.0	10.0			M
Endrin	0.0002	0.0002			M
Lindane	0.004	0.004			M
Methoxychlor	0.1	0.1			M
Toxaphene	0.005	0.005			M
2,4-D	0.1	0.1			M
2,4,5-TP Silvex	0.01	0.01			M
Trihalomethanes	0.1	0.1			
Turbidity (TU)	1.0	1.0			
Coliform bacteria — membrane filter test (#/100 ml)	1.0	1.0			M
Gross alpha (pCi/l)	15.0	15.0			M
Combined Radium 226 and Radium 228	5.0	5.0			M
Beta and photon particle activity (mrem/yr)	4.0	4.0			M
Sodium	M	M			M
Chloride	250.0	250.0			M
Color (units)	15.0	15.0			
Copper	1.0	1.0			
Corrosivity	Noncorrosive	Noncorrosive			
Foaming agents	0.5	0.5			
Iron	0.3	0.3			M
Manganese	0.05	0.05			M
Odor (threshold no.)	3.0	3.0			
pH (units)	6.5-8.5	6.5-8.5			M
Sulfate	250.0	250.0			M
Total dissolved solids	500.0	500.0			
Zinc	5.0	5.0			
Phenols					M
Specific conductance					M
Total organic carbon					M
Total organic halogen					M

Note: "M" denotes monitoring requirement. See Section 4.3.

ENVIRONMENTAL PROTECTION AGENCY NATIONAL INTERIM PRIMARY DRINKING WATER REGULATIONS

(40 CFR 141; 40 FR 59565, December 24, 1975; Amended by 41 FR 28402, July 9, 1976; 44 FR 68641, November 29, 1979; Corrected by 45 FR 15542, March 11, 1980; 45 FR 57342, August 27, 1980)

Title 40—Protection of Environment CHAPTER I—ENVIRONMENTAL PROTECTION AGENCY

SUBCHAPTER D—WATER PROGRAMS

PART 141—NATIONAL INTERIM PRIMARY DRINKING WATER REGULATIONS

Subpart A—General

Sec.

- 141.1 Applicability.
- 141.2 Definitions.
- 141.3 Coverage.
- 141.4 Variances and exemptions.
- 141.5 Siting requirements.
- 141.6 Effective dates.

Subpart B—Maximum Contaminant Levels

- 141.11 Maximum contaminant levels for inorganic chemicals.
- 141.12 Maximum contaminant levels for organic chemicals.
- 141.13 Maximum contaminant levels for turbidity.
- 141.14 Maximum microbiological contaminant levels.
- 141.15 Maximum contaminant levels for radium-226, radium-228, and gross alpha particle radioactivity in community water systems.
- 141.16 Maximum contaminant levels for beta particle and photon radioactivity from man-made radionuclides in community water systems.

Subpart C—Monitoring and Analytical Requirements

- 141.21 Microbiological contaminant sampling and analytical requirements.
- 141.22 Turbidity sampling and analytical requirements.
- 141.23 Inorganic chemical sampling and analytical requirements.
- 141.24 Organic chemicals other than total trihalomethanes, sampling and analytical requirements.
- 141.25 Analytical Methods for Radioactivity.
- 141.26 Monitoring Frequency for Radioactivity in Community Water Systems.
- 141.27 Alternative analytical techniques.
- 141.28 Approved laboratories.
- 141.29 Monitoring of consecutive public water systems.

Subpart D—Reporting Public Notification, and Record-keeping

- 141.31 Reporting requirements.
- 141.32 Public notification of variances, exemptions, and non-compliance with regulations.
- 141.33 Record maintenance.

Subpart E—Special Monitoring Regulations for Organic Chemicals

141.40 Special monitoring for organic chemicals.

Authority: Secs. 1412, 1414, 1445, and 1450 of the Public Health Service Act, 88 Stat. 1660 (42 U.S.C. 300g-1, 300g-3, 300j-4, and 300j-9).

Subpart A—General

§ 141.41 Applicability.

This part establishes primary drinking water regulations pursuant to section 1412 of the Public Health Service Act, as amended by the Safe Drinking Water Act (Pub. L. 93-523); and related regulations applicable to public water systems.

§ 141.42 Definitions.

As used in this part, the term:

(a) "Act" means the Public Health Service Act, as amended by the Safe Drinking Water Act, Pub. L. 93-523.

(b) "Contaminant" means any physical, chemical, biological, or radiological substance or matter in water.

(c) "Maximum contaminant level" means the maximum permissible level of a contaminant in water which is delivered to the free flowing outlet of the ultimate user of a public water system, except in the case of turbidity where the maximum permissible level is measured at the point of entry to the distribution system. Contaminants added to the water under circumstances controlled by the user, except those resulting from corrosion of piping and plumbing caused by water quality, are excluded from this definition.

(d) "Person" means an individual, corporation, company, association, partnership, State, municipality, or Federal agency.

(e) "Public water system" means a system for the provision to the public of piped water for human consumption, if such system has at least fifteen service connections or regularly serves an average of at least twenty-five individuals daily at least 60 days out of the year. Such term includes (1) any collection, treatment, storage, and distribution facilities under control of the operator of such system and used primarily in connection with such system, and (2) any collection or pretreatment storage facilities not under such control which are used primarily in connection with such system. A public water system is either

a "community water system" or a "non-community water system."

(i) "Community water system" means a public water system which has at least 15 service connections used by at least 25 year-round residents or regularly serves at least 25 year-round residents.

(ii) "Non-community water system" means a public water system which is not a community water system.

(f) "Sanitary survey" means a site review of the water source, facilities, equipment, operation and maintenance of a public water system for the purpose of evaluating the adequacy of such source, facilities, equipment, operation and maintenance for providing and distributing safe drinking water.

(g) "Standard sample" means a representative aliquot of finished drinking water examined for the presence of bacteria.

(h) "State" means the agency or State government which has jurisdiction over public water systems in any period when a State does not have primary enforcement responsibility pursuant to Section 1413 of the Act. The term "State" means the Regional Administrator, U.S. Environmental Protection Agency.

(i) "Supplier of water" means a person who owns or operates a public water system.

(j) "Dose equivalent" means a unit of the absorbed dose from radiation and such factors as account for differences in biological effectiveness to the type of radiation and its location in the body as specified by the International Commission on Radiological Units and Measurements (ICRU).

(k) "Rem" means the unit of dose equivalent from ionizing radiation to the total body or any internal organ or system. A "millirem (mrem)" is one-thousandth of a rem.

(l) "Picocurie (pCi)" means the activity of radioactive material which produces 2.22 nuclear transformations per second.

(m) "Gross alpha particle emission" means the total radioactivity of alpha particle emission as inferred from measurements on a dry sample.

(n) "Man-made beta particle emitter" means all radioactive materials which emit beta particles and/or gamma rays.

listed in Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure, NIOS Handbook 69, except the daughter products of thorium-232, uranium-235 and uranium-238.

(o) "Gross beta particle activity" means the total radioactivity due to beta particle emission as inferred from measurements on a dry sample.

[41 FR 28402, July 9, 1976]

[141.2 (p)-(t) added by 44 FR 68641, November 29, 1979]

(p) "Halogen" means one of the chemical elements chlorine, bromine or iodine.

(q) "Trihalomethane" (THM) means one of the family of organic compounds, named as derivatives of methane, wherein three of the four hydrogen atoms in methane are each substituted by a halogen atom in the molecular structure.

(r) "Total trihalomethane" (TTHM) means the sum of the concentration in milligrams per liter of the trihalomethane compounds (trichloromethane [chloroform], dibromochloromethane, bromodichloromethane and tribromomethane [bromoform]), rounded to two significant figures.

(s) "Maximum Total Trihalomethane Potential (MTP)" means the maximum concentration of total trihalomethanes produced in a given water containing a disinfectant residual after 7 days at a temperature of 25° C or above.

(t) "Disinfectant" means any oxidant, including but not limited to chlorine, chlorine dioxide, chloramines, and ozone added to water in any part of the treatment or distribution process, that is intended to kill or inactivate pathogenic microorganisms.

§ 141.3 Coverage.

This part shall apply to each public water system, unless the public water system meets all of the following conditions:

(a) Consists only of distribution and storage facilities (and does not have any collection and treatment facilities);

(b) Obtains all of its water from, but is not owned or operated by, a public water system to which such regulations apply;

(c) Does not sell water to any person; and

(d) Is not a carrier which conveys passengers in interstate commerce.

§ 141.4 Variances and exemptions.

Variances or exemptions from certain provisions of these regulations may be granted pursuant to Sections 1415 and 1416 of the Act by the entity with primary enforcement responsibility. Provisions under Part 142, *National Interim Primary Drinking Water Regulations Implementation*—subpart E (Variances)

and subpart F (Exemptions)—apply where EPA has primary enforcement responsibility.

§ 141.5 Siting requirements.

Before a person may enter into a financial commitment for or initiate construction of a new public water system or increase the capacity of an existing public water system, he shall notify the State, and, to the extent practicable, avoid locating part or all of the new or expanded facility at a site which:

(a) Is subject to a significant risk from earthquakes, floods, fires or other disasters which could cause a breakdown of the public water system or a portion thereof; or

(b) Except for intake structures, is within the floodplain of a 100-year flood or is lower than any recorded high tide where appropriate records exist. The U.S. Environmental Protection Agency will not seek to override land use decisions affecting public water systems siting which are made at the State or local government levels.

§ 141.6 Effective dates.

[141.6 revised by 44 FR 68641, November 29, 1979]

(a) Except as provided in paragraph (b) of this section, the regulations set forth in this part shall take effect on June 24, 1977.

(b) The regulations for total trihalomethanes set forth in § 141.12(c) shall take effect 2 years after the date of promulgation of these regulations for community water systems serving 75,000 or more individuals, and 4 years after the date of promulgation for communities serving 10,000 to 74,999 individuals.

(c) The regulations set forth in 141.11 (a), (c) and (d); 141.14(a)(1); 141.14(b)(1)(c); 141.14(b)(2)(i); 141.14(d); 141.21 (e), (c) and (i); 141.22 (a) and (e); 141.23 (a)(3) and (a)(4); 141.23(f); 141.24(a)(3); 141.24 (e) and (f); 141.25(e); 141.27(a); 141.28 (a) and (b); 141.31 (a), (c), (d) and (e); 141.32(b)(3); and 141.32(d) shall take effect immediately upon promulgation.

(d) The regulations set forth in 141.41 shall take effect 18 months from the date of promulgation. Suppliers must complete the first round of sampling and reporting within 12 months following the effective date.

(e) The regulations set forth in 141.42 shall take effect 18 months from the date of promulgation. All requirements in 141.42 must be completed within 12 months following the effective date.

[141.6 (c)-(e) added by 45 FR 57342, August 27, 1980]

Subpart B—Maximum Contaminant Levels § 141.11 Maximum contaminant level for inorganic chemicals.

(a) The MCL for nitrate is applicable to both community water systems and non-community water systems except as provided by in paragraph (d). The levels for the other organic chemicals apply only to community water systems. Compliance with MCLs for inorganic chemicals is calculated pursuant to § 141.23.

[141.11(a) amended by 45 FR 57342, August 27, 1980]

(b) The following are the maximum contaminant levels for inorganic chemicals other than fluoride:

Contaminant	Level, milligrams per liter
Arsenic	0.05
Barium	1
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10
Selenium	0.01
Silver	0.05

(c) When the annual average of the maximum daily air temperatures for the location in which the community water system is situated is the following, the maximum contaminant levels for fluoride are:

Temperature Degrees Fahrenheit	Temperature Degrees Celsius	Level, milligrams per liter
59.7 and below	15.0 and below	2.4
59.8 to 64.3	15.1 to 18.0	2.2
64.4 to 68.9	18.1 to 20.5	2.0
69.0 to 73.5	20.6 to 23.1	1.8
73.6 to 78.1	23.2 to 25.6	1.6
78.2 to 82.7	25.7 to 28.2	1.4

(c) Fluoride at optimum levels in drinking water has been shown to have beneficial effects in reducing the occurrence of tooth decay.

[141.11 (c) amended by 45 FR 57342, August 27, 1980]

(d) At the discretion of the State, nitrate levels not to exceed 20 mg/l may be allowed in a non-community water system if the supplier of water demonstrates to the satisfaction of the State that:

(1) Such water will not be available to children under 6 months of age; and

(2) There will be continuous posting of the fact that nitrate levels exceed 10 mg/l and the potential health effects of exposure; and

(3) Local and State public health authorities will be notified annually of nitrate levels that exceed 10 mg/l; and

(4) No adverse health effects shall result.

[141.11 (d) added by 45 FR 57342, August 27, 1980]

§ 141.12 Maximum contaminant levels for organic chemicals.

[141.12 revised by 44 FR 68641, November 29, 1979]

The following are the maximum contaminant levels for organic chemicals. The maximum contaminant levels for organic chemicals in paragraphs (a) and (b) of this section apply to all community water systems. Compliance with the maximum contaminant levels in paragraphs (a) and (b) is calculated pursuant to § 141.24. The maximum contaminant level for total trihalomethanes in paragraph (c) of this section applies only to community water systems which serve a population of 10,000 or more individuals and which add a disinfectant (oxidant) to the water in any part of the drinking water treatment process. Compliance with the maximum contaminant level for total trihalomethanes is calculated pursuant to § 141.30.

Level,
milligrams
per liter

- (a) Chlorinated hydrocarbons:
Endrin (1,2,3,4,10, 10-hexachloro-6,7-epoxy-1,4, 4a,5,6,7,8,8a-octa-hydro-1,4-endo, endo-5,8-dimeth-ano naphthalene). 0.0002
Lindane (1,2,3,4,5,6-hexachlorocyclohexane, gamma isomer). 0.004
Methoxychlor (1,1,1-Trichloro-2, 2-bis(p-methoxyphenyl) ethane) 0.1
Toxaphene (C₁₂H₈Cl₁₂, Technical chlorinated camphene, 67-69 per cent chlorine) 0.005

- (b) Chlorophenoxy acids:
2,4-D (2,4-Dichlorophenoxyacetic acid) 0.1
2,4,5-TP Silvex (2,4,5-Trichlorophenoxypropionic acid) 0.01

- (c) Total trihalomethanes (the sum of the concentrations of bromodichloromethane, dibromochloromethane, tribromomethane (bromochloroform) and trichloromethane (chloroform) 0.10 mg/l.

[141.12(c) added by 44 FR 68641, November 29, 1979]

§ 141.13 Maximum contaminant levels for turbidity.

The maximum contaminant levels for turbidity are applicable to both community water systems and non-community water systems using surface water sources in whole or in part. The maximum contaminant levels for turbidity in drinking water, measured at a representative entry point(s) to the distribution system, are

- (a) One turbidity unit (TU), as de-

termined by a monthly average pursuant to § 141.22, except that five or fewer turbidity units may be allowed if the supplier of water can demonstrate to the State that the higher turbidity does not do any of the following:

- (1) Interfere with disinfection;
 - (2) Prevent maintenance of an effective disinfectant agent throughout the distribution system; or
 - (3) Interfere with microbiological determinations.
- (b) Five turbidity units based on an average for two consecutive days pursuant to § 141.22.

§ 141.14 Maximum microbiological contaminant levels.

The maximum contaminant levels for coliform bacteria, applicable to community water systems and non-community water systems, are as follows:

- (a) When the membrane filter technique pursuant to § 141.21(a) is used, the number of coliform bacteria shall not exceed any of the following:

[141.14(a)(1) revised by 45 FR 57342, August 27, 1980]

- (1) One per 100 milliliters as the arithmetic mean of all samples examined per compliance period pursuant to § 141.21(b) or (c), except that, at the primacy Agency's discretion systems required to take 10 or fewer samples per month may be authorized to exclude one positive routine sample per month from the monthly calculation if:

(i) as approved on a case-by-case basis the State determines and indicates in writing to the public water system that no unreasonable risk to health existed under the conditions of this modification. This determination should be based upon a number of factors not limited to the following: (A) the system provided and had maintained an active disinfectant residual in the distribution system, (B) the potential for contamination as indicated by a sanitary survey, and (C) the history of the water quality at the public water system (e.g. MCL or monitoring violations); (ii) the supplier initiates a check sample on each of two consecutive days from the same sampling point within 24 hours after notification that the routine sample is positive, and each of these check samples is negative; and (iii) the original positive routine sample is reported and recorded by the supplier pursuant to § 141.31(a) and § 141.33(a). The supplier shall report to the State its compliance with the conditions specified in this paragraph and a summary of the corrective action taken to resolve the prior positive sample result. If a positive routine sample is not used for the monthly calculation, another routine

sample must be analyzed for compliance purposes. This provision may be used only once during two consecutive compliance periods.

- (2) Four per 100 milliliters in less than one sample when less than 20 samples are examined per month; or

- (3) Four per 100 milliliters in less than five percent of the samples 20 or more are examined per month.

(b)(1) When the fermentation method and 10 milliliter standard dilutions pursuant to § 141.21(a) are coliform bacteria shall not be present any of the following:

[141.14(b)(1)(ii) revised by 45 FR 57342, August 27, 1980]

(i) More than 10 percent of the portions (tubes) in any one month pursuant to § 141.21 (b) or (c) except that, at the State's discretion, systems required to take 10 or fewer samples per month may be authorized to exclude one positive routine sample resulting in 10 or more positive tubes per month from the monthly calculation if: (A) as approved on a case-by-case basis the State determines and indicates in writing to the public water system that no unreasonable risk to health existed under the conditions of this modification. This determination should be based upon a number of factors not limited to the following: (1) the system provided and had maintained an active disinfectant residual in the distribution system, (2) the potential for contamination as indicated by a sanitary survey, and (3) the history of the water quality at the public water system (e.g. MCL or monitoring violations); (B) the supplier initiates a check sample on each of two consecutive days from the sampling point within 24 hours after notification that the routine sample is positive, and each of these check samples is negative; and (C) the original positive routine sample is reported and recorded by the supplier pursuant to § 141.31(a) and § 141.33(a). The supplier shall report to the State its compliance with the conditions specified in this paragraph and report the action taken to resolve the prior positive sample result. If a positive routine sample is not used for the monthly calculation, another routine sample must be analyzed for compliance purposes. This provision may be used only once during two consecutive compliance periods.

- (ii) three or more portions in less than one sample when less than 20 samples are examined per month; or

- (iii) three or more portions in less than five percent of the samples 20 or more samples are examined per month.

- (2) When the fermentation

Friday
November 28, 1980

Part V

**Environmental
Protection Agency**

Water Quality Criteria Documents;
Availability

ENVIRONMENTAL PROTECTION AGENCY

[FRL 1623-J]

Water Quality Criteria Documents: Availability

AGENCY: Environmental Protection Agency.

ACTION: Notice of Water Quality Criteria Documents.

SUMMARY: EPA announces the availability and provides summaries of water quality criteria documents for 64 toxic pollutants or pollutant categories. These criteria are published pursuant to section 304(a)(1) of the Clean Water Act.

AVAILABILITY OF DOCUMENTS: Summaries of both aquatic-based and health-based criteria from the documents are published below. Copies of the complete documents for individual pollutants may be obtained from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, (703-487-4650). A list of the NTIS publication order numbers for all 64 criteria documents is published below. These documents are also available for public inspection and copying during normal business hours at: Public Information Reference Unit, U.S. Environmental Protection Agency, Room 2404 (rear), 401 M St., S.W., Washington, D.C. 20460. As provided in 40 CFR Part 2, a reasonable fee may be charged for copying services. Copies of these documents are also available for review in the EPA Regional Office libraries.

~~Copies of the documents are not available from the EPA Office listed below. Requests sent to that office will be forwarded to NTIS or returned to the sender.~~

1. Acenaphthene, PB81-117289.
2. Acrolein, PB81-117277.
3. Acrylonitrile, PB81-117285.
4. Aldrin/Dieldrin, PB81-117301.
5. Antimony, PB81-117319.
6. Arsenic, PB81-117327.
7. Asbestos, PB81-117335.
8. Benzene, PB81-117293.
9. Benzidine, PB81-117343.
10. Beryllium, PB81-117350.
11. Cadmium, PB81-117368.
12. Carbon Tetrachloride, PB81-117376.
13. Chlordane, PB81-117384.
14. Chlorinated benzenes, PB81-117392.
15. Chlorinated ethanes, PB81-117400.
16. Chloroalkyl ethers, PB81-117413.
17. Chlorinated naphthalene, PB81-117426.
18. Chlorinated phenols, PB81-117434.
19. Chloroform, PB81-117442.
20. 2-chlorophenol, PB81-117459.

21. Chromium, PB81-117467.
22. Copper, PB81-117475.
23. Cyanides, PB81-117483.
24. DDT, PB81-117491.
25. Dichlorobenzenes, PB81-117509.
26. Dichlorobenzidine, PB81-117517.
27. Dichloroethylenes, PB81-117525.
28. 2,4-dichlorophenol, PB81-117533.
29. Dichloropropanes/propenes, PB81-117541.
30. 2,4-dimethylphenol, PB81-117558.
31. Dinitrotoluene, PB81-117566.
32. Diphenylhydrazine, PB81-117731.
33. Endosulfan, PB81-117574.
34. Endrin, PB81-117582.
35. Ethylbenzene, PB81-117590.
36. Fluoranthene, PB81-117608.
37. Haloethers, PB81-117616.
38. Halomethanes, PB81-117624.
39. Heptachlor, PB81-117632.
40. Hexachlorobutadiene, PB81-117640.
41. Hexachlorocyclohexane, PB81-117657.
42. Hexachlorocyclopentadiene, PB81-117685.
43. Isophorone, PB81-117673.
44. Lead, PB81-117681.
45. Mercury, PB81-117699.
46. Naphthalene, PB81-117707.
47. Nickel, PB81-117715.
48. Nitrobenzene, PB81-117723.
49. Nitrophenols, PB81-117749.
50. Nitrosamines, PB81-117756.
51. Pentachlorophenol, PB81-117764.
52. Phenol, PB81-117772.
53. Phthalate esters, PB81-117780.
54. Polychlorinated biphenyls (PCBs), PB81-117798.
55. Polynuclear aromatic hydrocarbons, PB81-117805.
56. Selenium, PB81-117814.
57. Silver, PB81-117822.
58. Tetrachloroethylene, PB81-117830.
59. Thallium, PB81-117848.
60. Toluene, PB81-117855.
61. Toxaphene, PB81-117863.
62. Trichloroethylene, PB81-117871.
63. Vinyl chloride, PB81-117889.
64. Zinc, PB81-117897.

FOR FURTHER INFORMATION CONTACT: Dr. Frank Gostomski, Criteria and Standards Division (WH-585), United States Environmental Protection

Agency, Washington, D.C. 20460 (202) 245-3612.

SUPPLEMENTARY INFORMATION:

Background

Pursuant to section 304(a)(1) of the Clean Water Act, 33 U.S.C. 1314(a)(1), EPA is required to periodically review and publish criteria for water quality accurately reflecting the latest scientific knowledge:

(A) on the kind and extent of all identifiable effects on health and welfare including, but not limited to, plankton, fish,

shellfish, wildlife, plant life, shorelines, beaches, esthetics, and recreation which may be expected from the presence of pollutants in any body of water, including groundwater, (B) on the concentration and dispersal of pollutants, or their byproducts, through biological, physical, and chemical processes, and (C) on the effects of pollutants on biological community diversity, productivity, and stability, including information on the factors affecting rates of eutrophication and rates of organic and inorganic sedimentation for varying types of receiving waters.

EPA is today announcing the availability of criteria documents for 64 of the 65 pollutants designated as toxic under section 307(a)(1) of the Act. The document on TCDD (Dioxin) will be published within the next month after review of recent studies. Criteria for the section 307(a)(1) toxic pollutants being published today will replace the criteria for those same pollutants found in the EPA publication, *Quality Criteria for Water*, (the "Red Book.") Criteria for all other pollutants and water constituents found in the "Red Book" remain valid. The criteria published today have been derived using revised methodologies for determining pollutant concentrations that will, when not exceeded, reasonably protect human health and aquatic life. Draft criteria documents were made available for public comment (44 FR 15928, March 15, 1979; 44 FR 43660, July 25, 1979; 44 FR 56628, October 1, 1979). These final criteria have been derived after consideration of all comments received.

These criteria documents are also issued in satisfaction of the Settlement Agreement in *Natural Resources Defense Council, et al. v. Train*, 8 E.R.C. 2120 (1976), modified, 12 E.R.C. 1833 (D.D.C. 1979). Pursuant to paragraph 11 of that agreement, EPA is required to publish criteria documents for the 65 pollutants which Congress, in the 1977 amendments to the Act, designated as toxic under section 307(a)(1). These documents contain recommended maximum permissible pollutant concentrations consistent with the protection of aquatic organisms, human health, and some recreational activities. Although paragraph 11 imposes certain obligations on the Agency, it does not create additional authority.

The Development of Water Quality Criteria

Section 304(a)(1) criteria contain two essential types of information: (1) discussions of available scientific data on the effects of pollutants on public health and welfare, aquatic life and recreation, and (2) quantitative concentrations or qualitative assessments of the pollutants in water which will generally ensure water

quality adequate to support a specified water use. Under section 304(a)(1), these criteria are based solely on data and scientific judgments on the relationship between pollutant concentrations and environmental and human health effects. Criteria values do not reflect considerations of economic or technological feasibility.

Publication of water quality criteria of this type has been an ongoing process which EPA and its predecessor Agency, the Federal Water Pollution Control Administration, have been engaged in since 1968. At that time the first Federal compilation of water quality criteria, the so-called "Green Book" (*Water Quality Criteria*), was published. As now, these criteria contained both narrative discussions of the environmental effects of pollutants on a range of possible uses and concentrations of pollutants necessary to support these uses. Since that time, water quality criteria have been revised and expanded with publication of the "Blue Book" (*Water Quality Criteria 1972*) in 1973 and the "Red Book" (*Quality Criteria for Water*) in 1976.

Since publication of the Red Book there have been substantial changes in EPA's approach to assessing scientific data and deriving section 304(a)(1) criteria. Previous criteria were derived from a limited data base. For many pollutants, an aquatic life criterion was derived by multiplying the lowest concentration known to have acute lethal effect on half of a test group of an aquatic species (the LC50 value) by an application factor in order to protect against chronic effects. If data showed a substance to be bioaccumulative or to have other significant long-term effects, a factor was used to reduce the indicated concentrations to a level presumed to be protective. Criteria for the protection of human health were similarly derived by considering the pollutants' acute, chronic, and bioaccumulative effects on non-human mammals and humans.

Although a continuation of the process of criteria development, the criteria published today were derived using revised methodologies (Guidelines) for calculating the impact of pollutants on human health and aquatic organisms. These Guidelines consist of systematic methods for assessing valid and appropriate data concerning acute and chronic adverse effects of pollutants on aquatic organisms, non-human mammals, and humans. By use of these data in prescribed ways, criteria are formulated to protect aquatic life and human health from exposure to the pollutants. For

some pollutants, bioconcentration properties are used to formulate criteria protective of aquatic life uses. For almost all of the pollutants, bioconcentration properties are used to assess the relative extent of human exposure to the pollutant either directly through ingestion of water or indirectly through consumption of aquatic organisms. Human health criteria for carcinogens are presented as incremental risks to man associated with specific concentrations of the pollutant in ambient water. The Guidelines used to derive criteria protective of aquatic life and human health are fully described in appendices B and C, respectively, of this Notice.

The Agency believes that these Guidelines provide criteria which more accurately reflect the effects of these pollutants on human health and on aquatic organisms and their uses. They are based on a more rational and consistent approach for using scientific data. These Guidelines were developed by EPA scientists in consultation with scientists from outside the Agency and they have been subjected to intensive public comment.

Neither the Guidelines nor the criteria are considered inflexible doctrine. Even at this time, EPA is taking action to employ the resources of peer review groups, including the Science Advisory Board, to evaluate recently published data, and EPA is conducting its own evaluation of new data to determine whether revisions to the criteria documents would be warranted.

The criteria published today are based solely on the effect of a single pollutant. However, pollutants in combination may have different effects because of synergistic, additive, or antagonistic properties. It is impossible in these documents to quantify the combined effects of these pollutants, and persons using criteria should be aware that site-specific analysis of actual combinations of pollutants may be necessary to give more precise indications of the actual environmental impacts of a discharge.

Relationship of the Section 304(a)(1) Criteria to Regulatory Programs

Section 304(a)(1) criteria are not rules and they have no regulatory impact. Rather, these criteria present scientific data and guidance on the environmental effect of pollutants which can be useful to derive regulatory requirements based on considerations of water quality impacts. Under the Clean Water Act, these regulatory requirements may include the promulgation of water quality-based effluent limitations under section 302, water quality standards

under section 303, or toxic pollutant effluent standards under section 307. States are encouraged to begin to modify or if necessary, develop new programs necessary to support the implementation of regulatory controls for toxic pollutants. As appropriate, States may incorporate criteria for toxic pollutants, based on this guidance, into their water quality standards.

Section 304(a)(1) criteria have been most closely associated with the development of State water quality standards, and the "Red Book" values have, in the past, been the basis for EPA's assessments of the adequacy of State requirements. However, EPA is now completing a major review of its water quality standards policies and regulations. After consideration of comments received on an Advance Notice of Proposed Rulemaking (43 FR 29588, July 10, 1978) and the draft criteria documents, the Agency intends to propose, by the end of this year, a revised water quality standards regulation which will clarify the Agency's position on a number of significant standards issues.

With the publication of these criteria, however, it is appropriate to discuss EPA's current thinking on standards issues relating to their use. This discussion does not establish new regulatory requirements and is intended as guidance on the possible uses of these criteria and an indication of future rulemaking the Agency may undertake. No substantive requirements will be established without further opportunity for public comment.

Water Quality Standards

Section 303 of the Clean Water Act provides that water quality standards developed for all surface waters. A water quality standard consists basically of two parts: (1) A "designated use" for which the water body is to be protected (such as "agricultural," "recreation" or "fish and wildlife"); and (2) "criteria" which are numerical pollutant concentration limits or narrative statements necessary to preserve or achieve the designated use. A water quality standard is developed through State or Federal rulemaking proceedings and must be translated into enforceable effluent limitations in a point source (NPDES) permit or may form the basis of best management practices applicable to nonpoint source under section 208 of the Act.

Relationship of Section 304(a)(1) Criteria to the Criteria Component of State Water Quality Standards

In the ANPRM, EPA announced a policy of "presumptive applicability"

section 304(a)(1) criteria codified in the "Red Book." Presumptive applicability meant that a State had to adopt a criterion for a particular water quality parameter at least as stringent as the recommendation in the Red Book unless the State was able to justify a less stringent criterion based on: natural-background conditions, more recent scientific evidence, or local, site-specific information. EPA is rescinding the policy of presumptive applicability because it has proven to be too inflexible in actual practice.

Although the section 304(a)(1) criteria represent a reasonable estimate of pollutant concentrations consistent with the maintenance of designated water uses, States may appropriately modify these values to reflect local conditions. In certain circumstances, the criteria may not accurately reflect the toxicity of a pollutant because of the effect of local water quality characteristics or varying sensitivities of local populations. For example, in some cases, ecosystem adaptation may enable a viable, balanced aquatic population to exist in waters with high natural background levels of certain pollutants. Similarly, certain compounds may be more or less toxic in some waters because of differences in alkalinity, temperature, hardness, and other factors.

Methods for adjusting the section 304(a)(1) criteria to reflect these local differences are discussed below.

Relationship of Section 304(a)(1) Criteria to Designated Water Uses:

The criteria published today can be used to support the designated uses which are generally found in State standards. The following section discusses the relationship between the criteria and individual use classifications. Where a water body is designated for more than one use, criteria necessary to protect the most sensitive use should be applied.

1. Recreation: Recreational uses of water include such activities as swimming, wading, boating and fishing. Although insufficient data exist on the effects of toxic pollutants resulting from exposure through such primary contact as swimming, section 304(a)(1) criteria based on human health effects may be used to support this designated use where fishing is included in the State definition of "recreation." In this situation only the portion of the criterion based on fish consumption should be used.

2. Protection and Propagation of Fish and Other Aquatic Life: The section 304(a)(1) criteria based on toxicity to aquatic life may be used directly to support this designated use.

3. Agricultural and Industrial Uses: The section 304(a)(1) criteria were not specifically developed to reflect the impact of pollutants on agricultural and industrial uses. However, the criteria developed for human health and aquatic life are sufficiently stringent to protect these other uses. States may establish criteria specifically designed to protect these uses.

4. Public Water Supply: The drinking water exposure component of the human health effects criteria can apply directly to this use classification or may be appropriately modified depending upon whether the specific water supply system falls within the auspices of the Safe Drinking Water Act's (SDWA) regulatory control, and the type and level of treatment imposed upon the supply before delivery to the consumer. The SDWA controls the presence of toxic pollutants in finished ("end-of-tap") drinking water. A brief description of relevant sections of this Act is necessary to explain how the SDWA will work in conjunction with section 304(a)(1) criteria in protecting human health from the effects of toxics due to consumption of water.

Pursuant to section 1412 of the SDWA, EPA has promulgated "National Interim Primary Drinking Water Standards" for certain organic and inorganic substances. These standards establish "maximum contaminant levels" ("MCLs") which specify the maximum permissible level of a contaminant in water which may be delivered to a user of a public water system now defined as serving a minimum of 25 people. MCLs are established based on consideration of a range of factors including not only the health effects of the contaminants but also technological and economic feasibility of the contaminants' removal from the supply. EPA is required to establish revised primary drinking water regulations based on the effects of a contaminant on human health, and include treatment capability, monitoring availability, and costs. Under Section 1401(1)(D)(i) of the SDWA, EPA is also allowed to establish the minimum quality criteria for water which may be taken into a public water supply system.

Section 304(a)(1) criteria provide estimates of pollutant concentrations protective of human health, but do not consider treatment technology, costs and other feasibility factors. The section 304(a)(1) criteria also include fish bioaccumulation and consumption factors in addition to direct human drinking water intake. These numbers were not developed to serve as "end of tap" drinking water standards, and they have no regulatory significance under

the SDWA. Drinking water standards are established based on considerations, including technological and economic feasibility, not relevant to section 304(a)(1) criteria. Section 304(a)(1) criteria may be analogous to the recommended maximum contaminant levels (RMCLs) under section 1412(b)(1)(B) of the SDWA in which, based upon a report from the National Academy of Sciences, the Administrator should set target levels for contaminants in drinking water at which "no known or anticipated adverse effects occur and which allows an adequate margin of safety". RMCLs do not take treatment, cost, and other feasibility factors into consideration. Section 304(a)(1) criteria are, in concept, related to the health-based goals specified in the RMCLs. Specific mandates of the SDWA such as the consideration of multi-media exposure, as well as different methods for setting maximum contaminant levels under the two Acts, may result in differences between the two numbers.

MCLs of the SDWA, where they exist, control toxic chemicals in finished drinking water. However, because of variations in treatment and the fact that only a relatively small number of MCLs have been developed, ambient water criteria may be used by the States as a supplement to SDWA regulations. States will have the option of applying MCLs, section 304(a)(1) human health effects criteria, modified section 304(a)(1) criteria or controls more stringent than these three to protect against the effects of toxic pollutants by ingestion from drinking water.

For untreated drinking water supplies, States may control toxics in the ambient water through either use of MCLs (if they exist for the pollutants of concern), section 304(a)(1) human health effects criteria, or a more stringent contaminant level than the former two options.

For treated drinking water supplies serving less than 25 people, States may choose toxics control through application of MCLs (if they exist for the pollutants of concern and are attainable by the type of treatment) in the finished drinking water. States also have the options to control toxics in the ambient water by choosing section 304(a)(1) criteria, adjusted section 304(a)(1) criteria resulting from the reduction of the direct drinking water exposure component in the criteria calculation to the extent that the treatment procedure reduces the level of pollutants, or a more stringent contaminant level than the former three options.

For treated drinking water supplies serving 25 people or greater, States must control toxics down to levels at least as stringent as MCLs (where they exist for

the pollutants of concern) in the finished drinking water. However, States also have the options to control toxics in the ambient water by choosing section 304(a)(1) criteria, adjusted section 304(a)(1) criteria resulting from the reduction of the direct drinking water exposure component in the criteria calculation to the extent that the treatment process reduces the level of pollutants, or a more stringent contaminant level than the former three options.

Inclusion of Specific Pollutants in State Standards:

To date, EPA has not required that a State address any specific pollutant in its standards. Although all States have established standards for most conventional pollutants, the treatment of toxic pollutants has been much less extensive. In the ANPRM, EPA suggested a policy under which States would be required to address a set of pollutants and incorporate specific toxic pollutant criteria into water quality standards. If the State failed to incorporate these criteria, EPA would promulgate the standards based upon these criteria pursuant to section 303(c)(4)(B).

In the forthcoming proposed revision to the water quality standard regulations, a significant change in policy will be proposed relating to the incorporation of certain pollutants in State water quality standards. This proposal will differ from the proposal made in the ANPRM. The ANPRM proposed an EPA-published list of pollutants for which States would have had to develop water quality standards. This list might have contained some (or all) of the 65 toxic pollutants. However, the revised water quality standards regulation will propose a process by which EPA will assist States in identifying specific toxic pollutants required for assessment for possible inclusion in State water quality standards. For these pollutants, States will have the option of adopting the published criteria or of adjusting those criteria based on site-specific analysis.

These pollutants would generally represent the greatest threat to sustaining a healthy, balanced ecosystem in water bodies or to human health due to exposure directly or indirectly from water. EPA is currently developing a process to determine which pollutants a State must assess for possible inclusion in its water quality standards. Relevant factors might include the toxicity of the pollutant, the frequency and concentration of its discharge, its geographical distribution, the breadth of data underlying the

scientific assessment of its aquatic life and human health effects, and the technological and economic capacity to control the discharge of the pollutant. For some of the pollutants, all States may be required to assess them for possible inclusion in their standards. For others, assessment would be restricted to States or limited to specific water bodies where the pollutants pose a particular site-specific problem.

Criteria Modification Process

Flexibility is available in the application of these and any other valid water quality criteria to regulatory programs. Although in some cases they may be used by the States as developed, the criteria may be modified to reflect local environmental conditions and human exposure patterns before incorporation into programs such as water quality standards. If significant impacts of site-specific water quality conditions in the toxicities of pollutants can be demonstrated or significantly different exposure patterns of these pollutants to humans can be shown, section 304(a)(1) criteria may be modified to reflect these local conditions. The term "local" may refer to any appropriate geographic area where common aquatic environmental conditions or exposure patterns exist. Thus, "local" may signify a Statewide, regional, river reach, or entire river basin area. On the other hand, the criteria of some pollutants might be applicable nationwide without the need for adaptation to reflect local conditions. The degree of toxicity toward aquatic organisms and humans characteristic of these pollutants would not change significantly due to local water quality conditions.

EPA is examining a series of environmental factors or water quality parameters which might realistically be expected to affect the laboratory-derived water quality criterion recommendation for a specific pollutant. Factors such as hardness, pH, suspended solids, types of aquatic organisms present, etc. could impact on the chemical's effect in the aquatic environment. Therefore, local information can be assembled and analyzed to adjust the criterion recommendation if necessary.

The Guidelines for deriving criteria for the protection of aquatic life suggest several approaches for modifying the criteria. First, toxicity data, both acute and chronic, for local species could be substituted for some or all of the species used in deriving criteria for the water quality standard. The minimum data requirements should still be fulfilled in calculating a revised criterion. Second,

criteria may be specifically tailored to local water body by use of data from toxicity tests performed with that ambient water. A procedure such as this would account for local environmental conditions in formulating a criterion relevant to the local water body. Third, site-specific water quality characteristics resulting in either enhancement or mitigation of aquatic life toxicity for the pollutant could be factored into final formulation of the criterion. Finally, the criteria may be made more stringent to ensure protection of an individual species not otherwise adequately protected by any of the three modification procedures previously mentioned.

EPA does not intend to have States assess every local stream segment and lake in the country on an individual basis before determining if an adjustment is necessary. Rather, it is envisioned that water bodies having similar hydrological, chemical, physical, and biological properties will be grouped for the purpose of criteria adjustment. The purpose of this effort is to assist States in adapting the section 304(a) criteria to local conditions where needed, thereby precluding the setting of arbitrary and perhaps unnecessarily stringent or underprotective criteria in water body. In all cases, EPA will still be required, pursuant to section 303(c), to determine whether the State water quality standards are consistent with the goals of the Act, including a determination of whether State-established criteria are adequate to support a designated use.

Criteria for the Protection of Aquatic Life

Interpretation of the Criteria

The aquatic life criteria issued today are summarized in Appendix A of this Federal Register notice. Criteria have been formulated by applying a set of Guidelines to a data base for each pollutant. The criteria for the protection of aquatic life specify pollutant concentrations which, if not exceeded, should protect most, but not necessarily all, aquatic life and its uses. The Guidelines specify that criteria should be based on an array of data from organisms, both plant and animal, occupying various trophic levels. Based on these data, criteria can be derived which should be adequate to protect types of organisms necessary to support an aquatic community.

The Guidelines are not designed to derive criteria which will protect all life stages of all species under all conditions. Generally some life stage one or more tested species, and

probably some untested species, will have sensitivities below the maximum value or the 24-hour average under some conditions and would be adversely affected if the highest allowable pollutant concentrations and the worst conditions existed for a long time. In actual practice, such a situation is not likely to occur and thus the aquatic community as a whole will normally be protected if the criteria are not exceeded. In any aquatic community there is a wide range of individual species sensitivities to the effects of toxic pollutants. A criterion adequate to protect the most susceptible life stage of the most sensitive species would in many cases be more stringent than necessary to protect the overall aquatic community.

The aquatic life criteria specify both maximum and 24-hour average values. The combination of the two values is designed to provide adequate protection of aquatic life and its uses from acute and chronic toxicity and bioconcentration without being as restrictive as a one-number criterion would have to be to provide the same amount of protection. A time period of 24 hours was chosen in order to ensure that concentrations not reach harmful levels for unacceptably long periods. Averaging for longer periods, such as a week or a month for example, could permit high concentrations to persist long enough to produce significant adverse effects. A 24-hour period was chosen instead of a slightly longer or shorter period in recognition of daily fluctuations in waste discharges and of the influence of daily cycles of sunlight and darkness and temperature on both pollutants and aquatic organisms.

The maximum value, which is derived from acute toxicity data, prevents significant risk of adverse impact to organisms exposed to concentrations above the 24-hour average. Merely specifying the average value over a specified time period is insufficient because concentrations of chemicals higher than the average value can kill or cause irreparable damage in short periods. Furthermore, for some chemicals the effect of intermittent high exposures is cumulative. It is therefore necessary to place an upper limit on pollutant concentrations to which aquatic organisms might be exposed. The two-number criterion is intended to describe the highest average ambient water concentration which will produce a water quality generally suited to the maintenance of aquatic life while restricting the extent and duration of the excursions over that average to levels which will not cause harm. The only

way to assure the same degree of protection with a one-number criterion would be to use the 24-hour average as a concentration that is not to be exceeded at any time in any place.

Since some substances may be more toxic in freshwater than in saltwater, or vice versa, provision is made for deriving separate water quality criteria for freshwater and for saltwater for each substance. However, for some substances sufficient data may not be available to derive one or both of these criteria using the Guidelines.

Specific aquatic life criteria have not been developed for all of the 65 toxic pollutants. In those cases where there were insufficient data to allow the derivation of a criterion, narrative descriptions of apparent threshold levels for acute and/or chronic effects based on the available data are presented. These descriptions are intended to convey a sense of the degree of toxicity of the pollutant in the absence of a criterion recommendation.

Summary of the Aquatic Life Guidelines

The Guidelines for Deriving Water Quality Criteria for the Protection of Aquatic Life and its Uses were developed to describe an objective, internally consistent, and appropriate way of ensuring that water quality criteria for aquatic life would provide, on the average, a reasonable amount of protection without an unreasonable amount of overprotection or underprotection. The resulting criteria are not intended to provide 100 percent protection of all species and all uses of aquatic life all of the time, but they are intended to protect most species in a balanced, healthy aquatic community. The Guidelines are published as Appendix B of this Notice. Responses to public comments on these Guidelines are attached as Appendix D.

Minimum data requirements are identified in four areas: acute toxicity to animals (eight data points), chronic toxicity to animals (three data points), toxicity to plants, and residues. Guidance is also given for discarding poor quality data.

Data on acute toxicity are needed for a variety of fish and invertebrate species and are used to derive a Final Acute Value. By taking into account the number and relative sensitivities of the tested species, the Final Acute Value is designed to protect most, but not necessarily all, of the tested and untested species.

Data on chronic toxicity to animals can be used to derive a Final Chronic Value by two different means. If chronic values are available for a specified number and array of species, a final

chronic value can be calculated directly. If not, an acute-chronic ratio is derived and then used with the Final Acute Value to obtain the Final Chronic Value.

The Final Plant Value is obtained by selecting the lowest plant toxicity value based on measured concentrations.

The Final Residue Value is intended to protect wildlife which consume aquatic organisms and the marketability of aquatic organisms. Protection of the marketability of aquatic organisms is, in actuality, protection of a use of that water body ("commercial fishery"). Two kinds of data are necessary to calculate the Final Residue Value: a bioconcentration factor (BCF) and a maximum permissible tissue concentration, which can be an FDA action level or can be the result of a chronic wildlife feeding study. For lipid soluble pollutants, the BCF is normalized for percent lipids and then the Final Residue Value is calculated by dividing the maximum permissible tissue concentration by the normalized BCF and by an appropriate percent lipid value. BCFs are normalized for percent lipids since the BCF measured for any individual aquatic species is generally proportional to the percent lipids in that species.

If sufficient data are available to demonstrate that one or more of the final values should be related to a water quality characteristic, such as salinity, hardness, or suspended solids, the final value(s) are expressed as a function of that characteristic.

After the four final values (Final Acute Value, Final Chronic Value, Final Plant Value, and Final Residue Value) have been obtained, the criterion is established with the Final Acute Value becoming the maximum value and the lowest of the other three values becoming the 24-hour average value. All of the data used to calculate the four final values and any additional pertinent information are then reviewed to determine if the criterion is reasonable. If sound scientific evidence indicates that the criterion should be raised or lowered, appropriate changes are made as necessary.

The present Guidelines have been revised from the earlier published versions (43 FR 21506, May 18, 1978; 43 FR 29028, July 5, 1978; 44 FR 15926, March 15, 1979). Details have been added in many places and the concept of a minimum data base has been incorporated. In addition, three adjustment factors and the species sensitivity factor have been deleted. These modifications were the result of the Agency's analysis of public comments and comments received from the Science Advisory Board on earlier

versions of the Guidelines. These comments and the Resultant modifications are addressed fully in Appendix D to this notice.

Criteria for the Protection of Human Health

Interpretation of the Human Health Criteria

The human health criteria issued today are summarized in Appendix A of this Federal Register notice. Criteria for the protection of human health are presented for 62 of the 65 pollutants based on their carcinogenic, toxic, or organoleptic (taste and odor) properties. The meanings and practical uses of the criteria values are distinctly different depending on the properties on which they are based.

The objective of the health assessment portions of the criteria documents is to estimate ambient water concentrations which, in the case of non-carcinogens, prevent adverse health effects in humans, and in the case of suspect or proven carcinogens, represent various levels of incremental cancer risk.

Health assessments typically contain discussions of four elements: Exposure, pharmacokinetics, toxic effects, and criterion formulation.

The exposure section summarizes information on exposure routes: ingestion directly from water, indirectly from consumption of aquatic organisms found in ambient water, other dietary sources, inhalation, and dermal contact. Exposure assumptions are used to derive human health criteria. Most criteria are based solely on exposure from consumption of water containing a specified concentration of a toxic pollutant and through consumption of aquatic organisms which are assumed to have bioconcentrated pollutants from the water in which they live. Other multimedia routes of exposure such as air, non-aquatic diet, or dermal are not factored into the criterion formulation for the vast majority of pollutants due to lack of data. The criteria are calculated using the combined aquatic exposure pathway and also using the aquatic organism ingestion exposure route alone. In criteria reflecting both the water consumption and aquatic organism ingestion routes of exposure, the relative exposure contribution varies with the propensity of a pollutant to bioconcentrate, with the consumption of aquatic organisms becoming more important as the bioconcentration factor (BCF) increases. As additional information on total exposure is assembled for pollutants for which criteria reflect only the two specified

aquatic exposure routes, adjustments in water concentration values may be made. The Agency intends to publish guidance which will permit the States to identify significantly different exposure patterns for their populations. If warranted by the demonstration of significantly different exposure patterns, this will become an element of a process to adapt/modify human health-based criteria to local conditions, somewhat analogous to the aquatic life criteria modification process discussed previously. It is anticipated that States at their discretion will be able to set appropriate human health criteria based on this process.

The pharmacokinetics section reviews data on absorption, distribution, metabolism, and excretion to assess the biochemical fate of the compounds in the human and animal system. The toxic effects section reviews data on acute, subacute, and chronic toxicity, synergistic and antagonistic effects, and specific information on mutagenicity, teratogenicity, and carcinogenicity. From this review, the toxic effect to be protected against is identified taking into account the quality, quantity, and weight of evidence characteristic of the data. The criterion formulation section reviews the highlights of the text and specifies a rationale for criterion development and the mathematical derivation of the criterion number.

Within the limitations of time and resources, current published information of significance was incorporated into the human health assessments. Review articles and reports were used for data evaluation and synthesis. Scientific judgment was exercised in reviewing and evaluating the data in each criteria document and in identifying the adverse effects for which protective criteria were published.

Specific health-based criteria are developed only if a weight of evidence supports the occurrence of the toxic effect and if dose/response data exist from which criteria can be estimated.

Criteria for suspect or proven carcinogens are presented as concentrations in water associated with a range of incremental cancer risks to man. Criteria for non-carcinogens represent levels at which exposure to a single chemical is not anticipated to produce adverse effects in man. In a few cases, organoleptic (taste and odor) data form the basis for the criterion. While this type of criterion does not represent a value which directly affects human health, it is presented as an estimate of the level of a pollutant that will not produce unpleasant taste or odor either directly from water consumption or indirectly by consumption of aquatic

organisms found in ambient waters. The criterion developed in this manner is judged to be as useful as other types of criteria in protecting designated water uses. In addition, where data are available, toxicity-based criteria are also presented for pollutants with derived organoleptic criteria. The choice of criteria used in water quality standards for these pollutants will depend upon the designated use to be protected. In the case of a multiple use water body, the criterion protecting most sensitive use will be applied. Finally, for several pollutants no criteria are recommended due to a lack of information sufficient for quantitative criterion formulation.

Risk Extrapolation

Because methods do not now exist to establish the presence of a threshold carcinogenic effects, EPA's policy is that there is no scientific basis for estimating "safe" levels for carcinogens. The criteria for carcinogens, therefore, state that the recommended concentration for maximum protection of human health is zero. In addition, the Agency has presented a range of concentrations corresponding to incremental cancer risks of 10^{-7} to 10^{-6} (one additional case of cancer in populations ranging from ten million to 100,000, respectively). Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Summary of the Human Health Guidelines

The health assessments and corresponding criteria published today were derived based on *Guidelines on Methodology Used in the Preparation of Health Effect Assessment Chapters of the Consent Decree (Water Criteria Documents)* (the Guidelines) developed by EPA's Office of Research and Development. The estimation of health risks associated with human exposure to environmental pollutants requires predicting the effect of low doses for a lifetime in duration. A combination of epidemiological and animal dose/response data is considered the preferred basis for quantitative criterion derivation. The complete Guidelines are presented as Appendix C. Major issues associated with these Guidelines and responses to public comments are presented as Appendix E.

No-effect (non-carcinogen) or specified risk (carcinogen) concentrations were estimated by extrapolation from animal toxicity or

human epidemiology studies using the following basic exposure assumptions: a 70-kilogram male person (*Report of the Task Group on Reference Man*, International Commission for Radiation Protection, November 23, 1957) as the exposed individual; the average daily consumption of freshwater and estuarine fish and shellfish products equal to 6.5 grams/day; and the average ingestion of two liters/day of water (*Drinking Water and Health*, National Academy of Sciences, National Research Council, 1977). Criteria based on these assumptions are estimated to be protective of an adult male who experiences average exposure conditions.

Two basic methods were used to formulate health criteria, depending on whether the prominent adverse effect was cancer or other toxic manifestations. The following sections detail these methods.

Carcinogens

Extrapolation of cancer responses from high to low doses and subsequent risk estimation from animal data is performed using a linearized multi-stage model. This procedure is flexible enough to fit all monotonically-increasing dose response data, since it incorporates several adjustable parameters. The multi-stage model is a linear non-threshold model as was the "one-hit" model originally used in the proposed criteria documents. The linearized multi-stage model and its characteristics are described fully in Appendix C. The linear non-threshold concept has been endorsed by the four agencies in the Interagency Regulatory Liaison Group and is less likely to underestimate risk at the low doses typical of environmental exposure than other models that could be used. Because of the uncertainties associated with dose response, animal-to-human extrapolation and other unknown factors, because of the use of average exposure assumptions, and because of the serious public health consequences that could result if risk were underestimated, EPA believes that it is prudent to use conservative methods to estimate risk in the water quality criteria program. The linearized multistage model is more systematic and invokes fewer arbitrary assumptions than the "one-hit" procedure previously used.

It should be noted that extrapolation models provide estimates of risk since a variety of assumptions are built into any model. Models using widely different assumptions may produce estimates ranging over several orders of magnitude. Since there is at present no

way to demonstrate the scientific validity of any model, the use of risk extrapolation models is a subject of debate in the scientific community. However, risk extrapolation is generally recognized as the only tool available at this time for estimating the magnitude of health hazards associated with non-threshold toxicants and has been endorsed by numerous Federal agencies and scientific organizations, including EPA's Carcinogen Assessment Group, the National Academy of Sciences, and the Interagency Regulatory Liaison Group as a useful means of assessing the risks of exposure to various carcinogenic-pollutants.

Non-Carcinogens

Health criteria based on toxic effects of pollutants other than carcinogenicity are estimates of concentrations which are not expected to produce adverse effects in humans. They are based upon Acceptable Daily Intake (ADI) levels and are generally derived using no-observed-adverse-effect-level (NOAEL), data from animal studies although human data are used wherever available. The ADI is calculated using safety factors to account for uncertainties inherent in extrapolation from animal to man. In accordance with the National Research Council recommendations (*Drinking Water and Health*, National Academy of Sciences, National Research Council, 1977), safety factors of 10, 100, or 1,000 are used depending on the quality and quantity of data. In some instances extrapolations are made from inhalation studies or limits to approximate a human response from ingestion using the Stokinger-Woodward model (Journal of American Water Works Association, 1958). Calculations of criteria from ADIs are made using the standard exposure assumptions (2 liters of water, 6.5 grams of edible aquatic products, and an average body weight of 70 kg).

Dated: October 24, 1980.

Douglas M. Costle,
Administrator.

Appendix A—Summary of Water Quality Criteria

Acenaphthene

Freshwater Aquatic Life

The available data for acenaphthene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 1,700 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of acenaphthene to sensitive freshwater aquatic animals but

toxicity to freshwater algae occur at concentrations as low as 520 µg/l.

Saltwater Aquatic Life

The available data for acenaphthene indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 970 and 710 µg/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Toxicity to algae occurs at concentrations as low as 500 µg/l.

Human Health

Sufficient data is not available for acenaphthene to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 20 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Acrolein

Freshwater Aquatic Life

The available data for acrolein indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 68 and 21 µg/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for acrolein indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 55 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of acrolein to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of acrolein ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 320 µg/l.

For the protection of human health from the toxic properties of acrolein ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 780 µg/l.

Acrylonitrile

Freshwater Aquatic Life

The available data for acrylonitrile indicate that acute toxicity to freshwater aquatic life occurs at concentrations as

low as 7,550 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of acrylonitrile to sensitive freshwater aquatic life but mortality occurs at concentrations as low as 2,600 µg/l with a fish species exposed for 30 days.

Saltwater Aquatic Life

Only one saltwater species has been tested with acrylonitrile and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of acrylonitrile through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are .58 µg/l, .058 µg/l and .006 µg/l respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 6.5 µg/l, .65 µg/l and .065 µg/l respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Aldrin-Dieldrin

Dieldrin

Freshwater Aquatic Life

For dieldrin the criterion to protect fresh water aquatic life as derived using the Guidelines is 0.0019 µg/l as a 24-hour average and the concentration should not exceed 2.5 µg/l at any time.

Saltwater Aquatic Life

For dieldrin the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0019 µg/l as a 24-hour average and the concentration should not exceed 0.71 µg/l at any time.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of dieldrin through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold

assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are .71 ng/l, .071 ng/l, and .0071 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are .78 ng/l, .078 ng/l, and .0078 ng/l respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Aldrin

Freshwater Aquatic Life

For freshwater aquatic life the concentration of aldrin should not exceed 3.0 µg/l at any time. No data are available concerning the chronic toxicity of aldrin to sensitive freshwater aquatic life.

Saltwater Aquatic Life

For saltwater aquatic life the concentration of aldrin should not exceed 1.3 µg/l at any time. No data are available concerning the chronic toxicity of aldrin to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of aldrin through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are .74 ng/l, .074 ng/l, and .0074 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are .79 ng/l, .079 ng/l, and .0079 ng/l, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Antimony

Freshwater Aquatic Life

The available data for antimony indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 8,000 and 1,600 µg/l respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Toxicity to algae occurs at concentrations as low as 610 µg/l.

Saltwater Aquatic Life

No saltwater organisms have been adequately tested with antimony, and no statement can be made concerning acute or chronic toxicity.

Human Health

For the protection of human health from the toxic properties of antimony ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 148 µg/l.

For the protection of human health from the toxic properties of antimony ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 45,000 µg/l.

Arsenic

Freshwater Aquatic Life

For freshwater aquatic life the concentration of total recoverable trivalent inorganic arsenic should not exceed 440 µg/l at any time. Short-term effects on embryos and larvae of aquatic vertebrate species have been shown to occur at concentrations as low as 40 µg/l.

Saltwater Aquatic Life

The available data for total recoverable trivalent inorganic arsenic indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 598 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trivalent inorganic arsenic to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of arsenic through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are

estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 22 ng/L, 2.2 ng/L, and .22 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 175 ng/L, 17.5 ng/L, and 1.75 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Asbestos

Freshwater Aquatic Life

No freshwater organisms have been tested with any asbestiform mineral and no statement can be made concerning acute or chronic toxicity.

Saltwater Aquatic Life

No saltwater organisms have been tested with any asbestiform mineral and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of asbestos through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 300,000 fibers/1, 30,000 fibers/1, and 3,000 fibers/1, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Benzene

Freshwater Aquatic Life

The available data for benzene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 5,300 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of benzene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for benzene indicate that acute toxicity to saltwater

low as 5,100 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of benzene to sensitive saltwater aquatic life, but adverse effects occur at concentrations as low as 700 µg/L with a fish species exposed for 168 days.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of benzene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 6.8 µg/L, .68 µg/L, and .068 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 400 µg/L, 40.0 µg/L, and 4.0 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Benzidine

Freshwater Aquatic Life

The available data for benzidine indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 2,500 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of benzidine to sensitive freshwater aquatic life.

Saltwater Aquatic Life

No saltwater organisms have been tested with benzidine and no statement can be made concerning acute and chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of benzidine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of

cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 1.2 ng/L, .12 ng/L, and .01 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 5.3 ng/L, .53 ng/L, and .05 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Beryllium

Freshwater Aquatic Life

The available data for beryllium indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 130 and 5.3 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Hardness has a substantial effect on acute toxicity.

Saltwater Aquatic Life

The limited saltwater data base available for beryllium does not permit any statement concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of beryllium through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 37 ng/L, 3.7 ng/L, and .37 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 641 ng/L, 64.1 ng/L, and 6.41 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Cadmium

Freshwater Aquatic Life

For total recoverable cadmium the criterion (in µg/L) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given

by $c = \frac{1}{24} \left(\frac{1}{\text{hardness}} \right)^{-1.25}$ as a 24-hour average and the concentration (in $\mu\text{g/l}$) should not exceed the numerical value given by $c = \frac{1}{24} \left(\frac{1}{\text{hardness}} \right)^{-1.25}$ at any time. For example, at hardnesses of 50, 100, and 200 mg/l as CaCO_3 , the criteria are 0.012, 0.025, and 0.051 $\mu\text{g/l}$ respectively, and the concentration of total recoverable cadmium should not exceed 1.5, 3.6 and 6.3 $\mu\text{g/l}$ respectively, at any time.

Saltwater Aquatic Life

For total recoverable cadmium the criterion to protect saltwater aquatic life as derived using the Guidelines is 4.5 $\mu\text{g/l}$ as a 24-hour average and the concentration should not exceed 59 $\mu\text{g/l}$ at any time.

Human Health

The ambient water quality criterion for cadmium is recommended to be identical to the existing drinking water standard which is 10 $\mu\text{g/l}$. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Carbon Tetrachloride

Freshwater Aquatic Life

The available data for carbon tetrachloride indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 35,200 $\mu\text{g/l}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of carbon tetrachloride to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for carbon tetrachloride indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 50,000 $\mu\text{g/l}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of carbon tetrachloride to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of carbon tetrachloride through ingestion of contaminated water and contaminated aquatic organisms the ambient water concentration should be zero based on

the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 4.0 $\mu\text{g/l}$, 40 $\mu\text{g/l}$ and .04 $\mu\text{g/l}$ respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 89.4 $\mu\text{g/l}$, 8.94 $\mu\text{g/l}$ and .86 $\mu\text{g/l}$ respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Chlordane

Freshwater Aquatic Life

For chlordane the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0043 $\mu\text{g/l}$ as a 24-hour average and the concentration should not exceed 2.4 $\mu\text{g/l}$ at any time.

Saltwater Aquatic Life

For chlordane the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0040 $\mu\text{g/l}$ as a 24-hour average and the concentration should not exceed 0.09 $\mu\text{g/l}$ at any time.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of chlordane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 4.6 ng/l , .46 ng/l , and .046 ng/l respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 4.6 ng/l , .46 ng/l , and .046 ng/l respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Chlorinated Benzenes

Freshwater Aquatic Life

The available data for chlorinated benzenes indicate that acute toxicity to freshwater aquatic life occurs at

concentrations as low as 250 $\mu\text{g/l}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of the more toxic of the chlorinated benzenes to sensitive freshwater aquatic life. Toxicity occurs at concentrations as low as 50 $\mu\text{g/l}$ for a fish species exposed 7.5 days.

Saltwater Aquatic Life

The available data for chlorinated benzenes indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 10 and 120 $\mu\text{g/l}$ respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of hexachlorobenzene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding recommended criteria are 7.2 ng/l , .72 ng/l , and .072 ng/l respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 7.4 ng/l , .74 ng/l , and .074 ng/l respectively.

For the protection of human health from the toxic properties of 1,2,4,5-tetrachlorobenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 38 $\mu\text{g/l}$.

For the protection of human health from the toxic properties of 1,2,4,5-tetrachlorobenzene ingested through contaminated aquatic organisms also the ambient water criterion is determined to be 48 $\mu\text{g/l}$.

For the protection of human health from the toxic properties of pentachlorobenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 74 $\mu\text{g/l}$.

For the protection of human health from the toxic properties of pentachlorobenzene ingested through contaminated aquatic organisms also the ambient water criterion is determined to be 85 $\mu\text{g/l}$.

Using the present guidelines, a satisfactory criterion cannot be determined.

at this time due to the insufficiency in the available data for trichlorobenzenes.

For comparison purposes, two approaches were used to derive criterion levels for monochlorobenzene. Based on available toxicity data, for the protection of public health, the derived level is 488 µg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 20 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Chlorinated Ethanes

Freshwater Aquatic Life

The available freshwater data for chlorinated ethanes indicate that toxicity increases greatly with increasing chlorination, and that acute toxicity occurs at concentrations as low as 118,000 µg/L for 1,2-dichloroethane, 18,000 µg/L for two trichloroethanes, 9,320 µg/L for two tetrachloroethanes, 7,240 µg/L for pentachloroethane, and 980 µg/L for hexachloroethane. Chronic toxicity occurs at concentrations as low as 20,000 µg/L for 1,2-dichloroethane, 9,400 µg/L for 1,1,2-trichloroethane, 2,400 µg/L for 1,1,2,2-tetrachloroethane, 1,100 µg/L for pentachloroethane, and 540 µg/L for hexachloroethane. Acute and chronic toxicity would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available saltwater data for chlorinated ethanes indicate that toxicity increases greatly with increasing chlorination and that acute toxicity to fish and invertebrate species occurs at concentrations as low as 113,000 µg/L for 1,2-dichloroethane, 31,200 µg/L for 1,1,1-trichloroethane, 9,020 µg/L for 1,1,2,2-tetrachloroethane, 390 µg/L for pentachloroethane, and 940 µg/L for hexachloroethane. Chronic toxicity occurs at concentrations as low as 281 µg/L for pentachloroethane. Acute and chronic toxicity would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,2-dichloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this

chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 9.4 µg/L, 94 µg/L, and .094 µg/L respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 2,430 µg/L, 243 µg/L, and 24.3 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the protection of human health from the toxic properties of 1,1,1-trichloroethane ingested through water and contaminated aquatic organism, the ambient water criterion is determined to be 18.4 mg/L.

For the protection of human health from the toxic properties of 1,1,1-trichloroethane ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 1.03 g/L.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,1,2-trichloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time.

Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 6.0 µg/L, 6 µg/L, and .06 µg/L respectively.

If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 418 µg/L, 41.8 µg/L, and 4.18 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,1,2,2-tetrachloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} ,

and 10^{-4} . The corresponding criteria are 1.7 µg/L, .17 µg/L, and .017 µg/L respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 107 µg/L, 10.7 µg/L, and 1.07 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of hexachloroethane through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time.

Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 19 µg/L, 1.9 µg/L, and .19 µg/L respectively.

If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 87.4 µg/L, 8.74 µg/L, and .87 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for monochloroethane.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for 1,1-dichloroethane.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for 1,1,1,2-tetrachloroethane.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for pentachloroethane.

Chlorinated Naphthalenes

Freshwater Aquatic Life

The available data for chlorinated naphthalenes indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 1,600 µg/L and would occur at lower concentrations among species that are

more sensitive than those tested. No data are available concerning the chronic toxicity of chlorinated naphthalenes to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for chlorinated naphthalenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 7.5 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of chlorinated naphthalenes to sensitive saltwater aquatic life.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for chlorinated naphthalenes.

Chlorinated Phenols

Freshwater Aquatic Life

The available freshwater data for chlorinated phenols indicate that toxicity generally increases with increasing chlorination, and that acute toxicity occurs at concentrations as low as 30 µg/l for 4-chloro-3-methylphenol to greater than 500,000 µg/l for other compounds. Chronic toxicity occurs at concentrations as low as 970 µg/l for 2,4,6-trichlorophenol. Acute and chronic toxicity would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available saltwater data for chlorinated phenols indicate that toxicity generally increases with increasing chlorination and that acute toxicity occurs at concentrations as low as 440 µg/l for 2,3,5,6-tetrachlorophenol and 29,700 µg/l for 4-chlorophenol. Acute toxicity would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of chlorinated phenols to sensitive saltwater aquatic life.

Human Health

Sufficient data is not available for 3-monochlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.1 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no

demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 4-monochlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.1 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,3-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is .04 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,5-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is .5 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,6-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 2 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 3,4-dichlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 3 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2,3,4,6-tetrachlorophenol to derive a

level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

For comparison purposes, two approaches were used to derive criterion levels for 2,4,5-trichlorophenol. Based on available toxicity data, for the protection of public health, the derived level is 2.6 mg/l. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 2,4,6-trichlorophenol through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5} , 10^{-6} , and 10^{-7} . The corresponding criteria are 12 µg/l, 1.2 µg/l, and .12 µg/l respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 36 µg/l, 3.6 µg/l, and .36 µg/l respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 2 µg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 2-methyl-4-chlorophenol to derive a level which would protect against any potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1800 µg/l. It should be

recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 3-methyl-4-chlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 3000 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Sufficient data is not available for 3-methyl-5-chlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 20 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Chloroalkyl Ethers

Freshwater Aquatic Life

The available data for chloroalkyl ethers indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 238,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of chloroalkyl ethers to sensitive freshwater aquatic life.

Saltwater Aquatic Life

No saltwater organisms have been tested with any chloroalkyl ether and no statement can be made concerning acute and chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of bis-(chloromethyl)-ether through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are .038 ng/L, .0038 ng/L and .00038 ng/L, respectively.

If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 18.4 ng/L, 1.84 ng/L, and .184 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of bis-(2-chloroethyl)-ether through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 3 µg/L, .03 µg/L, and .003 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 13.8 µg/L, 1.38 µg/L, and .138 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the protection of human health from the toxic properties of bis-(2-chloroisopropyl)-ether ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 34.7 µg/L.

For the protection of human health from the toxic properties of bis-(2-chloroisopropyl)-ether ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 4.38 mg/L.

Chloroform

Freshwater Aquatic Life

The available data for chloroform indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 28,800 µg/L and would occur at lower concentrations among species that are more sensitive than the three tested species. Twenty-seven-day LC50 values indicate that chronic toxicity occurs at concentrations as low as 1,240 µg/L and could occur at lower concentrations among species or other life stages that are more sensitive than the earliest life cycle stage of the rainbow trout.

Saltwater Aquatic Life

The data base for saltwater species is limited to one test and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of chloroform through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 1.90 µg/L, .19 µg/L, and .019 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 157 µg/L, 15.7 µg/L, and 1.57 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

2-Chlorophenol

Freshwater Aquatic Life

The available data for 2-chlorophenol indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 4,380 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of 2-chlorophenol to sensitive freshwater aquatic life but flavor impairment occurs in one species of fish at concentrations as low as 2,000 µg/L.

Saltwater Aquatic Life

No saltwater organisms have been tested with 2-chlorophenol and no statement can be made concerning acute and chronic toxicity.

Human Health

Sufficient data is not available for 2-chlorophenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.1 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no

demonstrated relationship to potential adverse human health effects.

Chromium

Freshwater Aquatic Life

For total recoverable hexavalent chromium the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.29 µg/l as a 24-hour average and the concentration should not exceed 21 µg/l at any time.

For freshwater aquatic life the concentration (in µg/l) of total recoverable trivalent chromium should not exceed the numerical value given by " $e(1.08[\ln(\text{hardness})] + 3.48)$ " at any time. For example, at hardnesses of 50, 100 and 200 mg/l as CaCO₃, the concentration of total recoverable trivalent chromium should not exceed 2,200, 4,700, and 9,900 µg/l, respectively, at any time. The available data indicate that chronic toxicity to freshwater aquatic life occurs at concentrations as low as 44 µg/l and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

For total recoverable hexavalent chromium the criterion to protect saltwater aquatic life as derived using the Guidelines is 18 µg/l as a 24-hour average and the concentration should not exceed 1,260 µg/l at any time.

For total recoverable trivalent chromium, the available data indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 10,300 µg/l, and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trivalent chromium to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of Chromium III ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 170 µg/l.

For the protection of human health from the toxic properties of Chromium III ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 3433 µg/l.

The ambient water quality criterion for total Chromium VI is recommended to be identical to the existing drinking water standard which is 50 µg/l. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The

calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Copper

Freshwater Aquatic Life

For total recoverable copper the criterion to protect freshwater aquatic life as derived using the Guidelines is 5.6 µg/l as a 24-hour average and the concentration (in µg/l) should not exceed the numerical value given by $e(0.94[\ln(\text{hardness})] - 1.23)$ at any time. For example, at hardnesses of 50, 100, and 200 mg/l CaCO₃, the concentration of total recoverable copper should not exceed 12, 22, and 43 µg/l at any time.

Saltwater Aquatic Life

For total recoverable copper the criterion to protect saltwater aquatic life as derived using the Guidelines is 4.0 µg/l as a 24-hour average and the concentration should not exceed 23 µg/l at any time.

Human Health

Sufficient data is not available for copper to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1 mg/l. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Cyanide

Freshwater Aquatic Life

For free cyanide (sum of cyanide present as HCN and CN⁻, expressed as CN) the criterion to protect freshwater aquatic life as derived using the Guidelines is 3.5 µg/l as a 24-hour average and the concentration should not exceed 52 µg/l at any time.

Saltwater Aquatic Life

The available data for free cyanide (sum of cyanide present as HCN and CN⁻, expressed as CN) indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 30 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. If the acute-chronic ratio for saltwater organisms is similar to that for freshwater organisms, chronic toxicity would occur at concentrations as low as 2.0 µg/l for the tested species and at lower concentrations among species

that are more sensitive than those tested.

Human Health

The ambient water quality criterion for cyanide is recommended to be identical to the existing drinking water standard which is 200 µg/l. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

DDT and Metabolites

Freshwater Aquatic Life

DDT

For DDT and its metabolites the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0010 µg/l as a 24-hour average and the concentration should not exceed 1.1 µg at any time.

TDE

The available data for TDE indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 0.6 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of TDE to sensitive freshwater aquatic life.

DDE

The available data for DDE indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 1.050 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of DDE to sensitive freshwater aquatic life.

Saltwater Aquatic Life

DDT

For DDT and its metabolites the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0010 µg/l as a 24-hour average and the concentration should not exceed 0.13 µg/l at any time.

TDE

The available data for TDE indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 3.8 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the

chronic toxicity of TDE to sensitive saltwater aquatic life.

DDE

The available data for DDE indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 14 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of DDE to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of DDT through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are 24 ng/l, .024 ng/l, and .0024 ng/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 24 ng/l, .024 ng/l, and .0024 ng/l, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment of an "acceptable" risk level.

Dichlorobenzenes

Freshwater Aquatic Life

The available data for dichlorobenzenes indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 1120 and 763 µg/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for dichlorobenzenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 1,970 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dichlorobenzenes to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of dichlorobenzenes (all isomers) ingested

through water and contaminated aquatic organisms, the ambient water criterion is determined to be 400 µg/l.

For the protection of human health from the toxic properties of dichlorobenzenes (all isomers) ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 2.6 mg/l.

Dichlorobenzidines

Freshwater Aquatic Life

The data base available for dichlorobenzidines and freshwater organisms is limited to one test on bioconcentration of 3.3'-dichlorobenzidine and no statement can be made concerning acute or chronic toxicity.

Saltwater Aquatic Life

No saltwater organisms have been tested with any dichlorobenzidine and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of dichlorobenzidine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are .103 µg/l, .0103 µg/l, and .00103 µg/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are .204 µg/l, .0204 µg/l, and .00204 µg/l, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Dichloroethylenes

Freshwater Aquatic Life

The available data for dichloroethylenes indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 11,600 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of dichloroethylenes to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for dichloroethylenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 224,000 and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dichloroethylenes to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,1-dichloroethylene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for the chemical. However, zero level may not be attainable at the present time.

Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-4} , 10^{-5} , and 10^{-6} . The corresponding criteria are .33 µg/l, .033 µg/l, and .0033 µg/l, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 18.5 µg/l, 1.85 µg/l, and .185 µg/l, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Using the present guidelines, a satisfactory criterion cannot be determined at this time due to the insufficiency in available data for 1,2-dichloroethylene.

2,4-Dichlorophenol

Freshwater Aquatic Life

The available data for 2,4-dichlorophenol indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 2,020 and 365 µg/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Mortality to early life stages of one species of fish occurs at concentrations as low as 70 µg/l.

Saltwater Aquatic Life

Only one test has been conducted with saltwater organisms on 2,4-dichlorophenol and no statement can be made concerning acute or chronic toxicity.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for 2,4-dichlorophenol.

Based on available toxicity data, for the protection of public health, the derived level is 3.09 mg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 0.3 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Dichloropropanes/Dichloropropenes *Freshwater Aquatic Life*

The available data for dichloropropanes indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 23,000 and 5,700 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

The available data for dichloropropenes indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 6,060 and 244 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for dichloropropanes indicate that acute and chronic toxicity to saltwater aquatic life occurs at concentrations as low as 10,300 and 3,040 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

The available data for dichloropropenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 790 µg/L, and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dichloropropenes to sensitive saltwater aquatic life.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for dichloropropanes.

For the protection of human health from the toxic properties of dichloropropenes ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 87 µg/L.

For the protection of human health from the toxic properties of dichloropropenes ingested through contaminated aquatic organisms alone,

the ambient water criterion is determined to be 14.1 mg/L.

2,4-Dimethylphenol

Freshwater Aquatic Life

The available data for 2,4-dimethylphenol indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 2,120 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of dimethylphenol to sensitive freshwater aquatic life.

Saltwater Aquatic Life

No saltwater organisms have been tested with 2,4-dimethylphenol and no statement can be made concerning acute and chronic toxicity.

Human Health

Sufficient data are not available for 2,4-dimethylphenol to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 400 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

2,4-Dinitrotoluene

Freshwater Aquatic Life

The available data for 2,4-dinitrotoluene indicate that acute and chronic toxicity to freshwater aquatic life occurs at concentrations as low as 330 and 230 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for 2,4-dinitrotoluenes indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 590 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of 2,4-dinitrotoluenes to sensitive saltwater aquatic life but a decrease in algal cell numbers occurs at concentrations as low as 370 µg/L.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 2,4-dinitrotoluene through ingestion of contaminated water and contaminated

aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for the chemical. However, zero level may not be attainable at the present time.

Therefore, the levels which may result in an incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 1.1 µg/L, 0.11 µg/L, and 0.011 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 91 µg/L, 9.1 µg/L, and 0.91 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

1,2-Diphenylhydrazine

Freshwater Aquatic Life

The available data for 1,2-diphenylhydrazine indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 270 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of 1,2-diphenylhydrazine to sensitive freshwater aquatic life.

Saltwater Aquatic Life

No saltwater organisms have been tested with 1,2-diphenylhydrazine and no statement can be made concerning acute and chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of 1,2-diphenylhydrazine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for the chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in an incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 422 ng/L, 42 ng/L, and 4 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 5.6 µg/L, 0.56 µg/L, and 0.056 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not

represent an Agency judgment on an "acceptable" risk level.

Endosulfan

Freshwater Aquatic Life

For endosulfan the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.058 µg/l as a 24-hour average and the concentration should not exceed 0.22 µg/l at any time.

Saltwater Aquatic Life

For endosulfan the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0087 µg/l as a 24-hour average and the concentration should not exceed 0.034 µg/l at any time.

Human Health

For the protection of human health from the toxic properties of endosulfan ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 74 µg/l.

For the protection of human health from the toxic properties of endosulfan ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 159 µg/l.

Endrin

Freshwater Aquatic Life

For endrin the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0023 µg/l as a 24-hour average and the concentration should not exceed 0.18 µg/l at any time.

Saltwater Aquatic Life

For endrin the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0023 µg/l as a 24-hour average and the concentration should not exceed 0.037 µg/l at any time.

Human Health

The ambient water quality criterion for endrin is recommended to be identical to the existing drinking water standard which is 1 µg/l. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.3 grams of aquatic organisms was not derived.

Ethylbenzene

Freshwater Aquatic Life

The available data for ethylbenzene indicate that acute toxicity to freshwater

aquatic life occurs at concentrations as low as 32,000 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of ethylbenzene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for ethylbenzene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 430 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of ethylbenzene to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of ethylbenzene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 1.4 mg/l.

For the protection of human health from the toxic properties of ethylbenzene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 3.28 mg/l.

Fluoranthene

Freshwater Aquatic Life

The available data for fluoranthene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 3980 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of fluoranthene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for fluoranthene indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 40 and 18 µg/l respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the protection of human health from the toxic properties of fluoranthene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 42 µg/l.

For the protection of human health from the toxic properties of fluoranthene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 54 µg/l.

Haloethers

Freshwater Aquatic Life

The available data for haloethers indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 360 and 122 µg/l respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

No saltwater organisms have been tested with any haloether and no statement can be made concerning acute or chronic toxicity.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for haloethers.

Halomethanes

Freshwater Aquatic Life

The available data for halomethanes indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 11,000 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of halomethanes to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for halomethanes indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 12,000 and 6,400 µg/l respectively, and would occur at lower concentrations among species that are more sensitive than those tested. A decrease in algal cell numbers occurs at concentrations as low as 11,500 µg/l.

Human Health

For the maximum protection of human health from the potential carcinogen effects due to exposure of chloromethane, bromomethane, dichloromethane, bromodichloromethane, tribromomethane, dichlorodifluoromethane, trichlorofluoromethane, or combination of these chemicals through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for chemical. However, zero level may be attainable at the present time. Therefore, the levels which may result in an incremental increase of cancer risk the lifetimes are estimated at 10^{-4} and 10^{-5} . The corresponding criterion

1.9 µg/L, 0.19 µg/L and 0.019 µg/L respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 157 µg/L, 15.7 µg/L and 1.57 µg/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Heptachlor

Freshwater Aquatic Life

For heptachlor the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.0038 µg/l as a 24-hour average and the concentration should not exceed 0.52 µg/l at any time.

Saltwater Aquatic Life

For heptachlor the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.0038 µg/l as a 24-hour average and the concentration should not exceed 0.053 µg/l at any time.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of heptachlor through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-4} , and 10^{-2} . The corresponding criteria are 2.78 ng/L, .28 ng/L and .028 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 2.85 ng/L, .29 ng/L, and .029 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Hexachlorobutadiene

Freshwater Aquatic Life

The available data for hexachlorobutadiene indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 90 and 9.3 µg/L respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for hexachlorobutadiene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 32 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of hexachlorobutadiene to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of hexachlorobutadiene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-4} , and 10^{-2} . The corresponding criteria are 4.47 µg/L, 0.45 µg/L and 0.045 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 500 µg/L, 50 µg/L and 5 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Hexachlorocyclobexane

Lindane

Freshwater Aquatic Life

For Lindane the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.080 µg/l as a 24-hour average and the concentration should not exceed 2.0 µg/l at any time.

Saltwater Aquatic Life

For saltwater aquatic life the concentration of lindane should not exceed 0.16 µg/l at any time. No data are available concerning the chronic toxicity of lindane to sensitive saltwater aquatic life.

BHC

Freshwater Aquatic Life

The available data for a mixture of isomers of BHC indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 100 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available

concerning the chronic toxicity of a mixture of isomers of BHC to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for a mixture of isomers of BHC indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 0.34 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of a mixture of isomers of BHC to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of alpha-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-4} , and 10^{-2} . The corresponding criteria are 82 ng/L, 8.2 ng/L and .82 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 310 ng/L, 31.0 ng/L and 3.1 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of beta-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-4} , and 10^{-2} . The corresponding criteria are 163 ng/L, 16.3 ng/L and 1.63 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 547 ng/L, 54.7 ng/L and 5.47 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not

represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of tech-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 123 ng/L, 123 ng/L, and 1.23 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 414 ng/L, 41.4 ng/L, and 4.14 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of gamma-HCH through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentrations should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time.

Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 186 ng/L, 18.6 ng/L, and 1.86 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 625 ng/L, 62.5 ng/L, and 6.25 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for delta-HCH.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for epsilon-HCH.

Hexachlorocyclopentadiene

Freshwater Aquatic Life

The available data for hexachlorocyclopentadiene indicate that acute and chronic toxicity to freshwater

aquatic life occurs at concentrations as low as 7.0 and 5.2 $\mu\text{g/L}$, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data to hexachlorocyclopentadiene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 7.0 $\mu\text{g/L}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of hexachlorocyclopentadiene to sensitive saltwater aquatic life.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for hexachlorocyclopentadiene. Based on available toxicity data, for the protection of public health, the derived level is 206 $\mu\text{g/L}$. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 1.0 $\mu\text{g/L}$. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Isophorone

Freshwater Aquatic Life

The available data for isophorone indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 117,000 $\mu\text{g/L}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of isophorone to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for isophorone indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 12,900 $\mu\text{g/L}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of isophorone to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of isophorone ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 5.2 mg/L.

For the protection of human health from the toxic properties of isophorone

ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 520 mg/L.

Lead

Freshwater Aquatic Life

For total recoverable lead the criterion (in $\mu\text{g/L}$) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by $e(2.35[\ln(\text{hardness})] - 9.49)$ as a 24-hour average and the concentration ($\mu\text{g/L}$) should not exceed the numerical value given by $e(1.22[\ln(\text{hardness})] - 0.1)$ at any time. For example, at hardness of 50, 100, and 200 mg/L as CaCO_3 , the criteria are 0.75, 3.8, and 20 $\mu\text{g/L}$, respectively, as 24-hour averages, and the concentrations should not exceed 170, and 400 $\mu\text{g/L}$, respectively, at any time.

Saltwater Aquatic Life

The available data for total recoverable lead indicate that acute and chronic toxicity to saltwater aquatic life occurs at concentrations as low as 668 and 25 $\mu\text{g/L}$, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

The ambient water quality criterion for lead is recommended to be identical to the existing drinking water standard which is 50 $\mu\text{g/L}$. Analysis of the toxic effects data resulted in a calculated level which is protective to human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Mercury

Freshwater Aquatic Life

For total recoverable mercury the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.00057 $\mu\text{g/L}$ as a 24-hour average and the concentration should not exceed 0.0017 $\mu\text{g/L}$ at any time.

Saltwater Aquatic Life

For total recoverable mercury the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.02 $\mu\text{g/L}$ as a 24-hour average and the concentration should not exceed 3.7 $\mu\text{g/L}$ at any time.

Human Health

For the protection of human health from the toxic properties of mercury

ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 144 ng/L.

For the protection of human health from the toxic properties of mercury ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 148 ng/L.

Note.—These values include the consumption of freshwater, estuarine, and marine species.

Naphthalene

Freshwater Aquatic Life

The available data to naphthalene indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 2,300 and 620 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for naphthalene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2,350 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of naphthalene to sensitive saltwater aquatic life.

Human Health

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for naphthalene.

Nickel

Freshwater Aquatic Life

For total recoverable nickel the criterion (in µg/L) to protect freshwater aquatic life as derived using the Guidelines is the numerical value given by $e(0.76[\ln(\text{hardness})] + 1.06)$ as a 24-hour average and the concentration (in µg/L) should not exceed the numerical value given by $e(0.76[\ln(\text{hardness})] + 4.02)$ at any time. For example, at hardnesses of 50, 100, and 200 mg/L as CaCO_3 , the criteria are 58, 96, and 160 µg/L, respectively, as 24-hour averages, and the concentrations should not exceed 1,100, 1,800, and 3,100 µg/L, respectively, at any time.

Saltwater Aquatic Life

For total recoverable nickel the criterion to protect saltwater aquatic life as derived using the Guidelines is 7.1 µg/L as a 24-hour average and the concentration should not exceed 140 µg/L at any time.

Human Health

For the protection of human health from the toxic properties of nickel ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13.4 µg/L.

For the protection of human health from the toxic properties of nickel ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 100 µg/L.

Nitrobenzene

Freshwater Aquatic Life

The available data for nitrobenzene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 27,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No definitive data are available concerning the chronic toxicity of nitrobenzene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for nitrobenzene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 6,680 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrobenzene to sensitive saltwater aquatic life.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for nitrobenzene. Based on available toxicity data, for the protection of public health, the derived level is 19.8 mg/L. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 30 µg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have no demonstrated relationship to potential adverse human health effects.

Nitrophenols

Freshwater Aquatic Life

The available data for nitrophenols indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 230 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrophenols to sensitive freshwater aquatic life but toxicity to one species of algae occurs at concentrations as low as 150 µg/L.

Saltwater Aquatic Life

The available data for nitrophenols indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 4,850 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrophenols to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of 2,4-dinitro-cresol ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13.4 µg/L.

For the protection of human health from the toxic properties of 2,4-dinitro-cresol ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 70 µg/L.

For the protection of human health from the toxic properties of dinitrophenol ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 70 µg/L.

For the protection of human health from the toxic properties of dinitrophenol ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 14.3 mg/L.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for mononitrophenols.

Using the present guidelines, a satisfactory criterion cannot be derived at this time due to the insufficiency in the available data for tri-nitrophenols.

Nitrosamines

Freshwater Aquatic Life

The available data for nitrosamine indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 3,850 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrosamines to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for nitrosamine indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 3,300,000 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of nitrosamines to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of *n*-nitrosodimethylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 14 ng/L, 1.4 ng/L, and .14 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 160,000 ng/L, 16,000 ng/L, and 1,600 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure of *n*-nitrosodiethylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 8 ng/L, 0.8 ng/L, and 0.08 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 12,400 ng/L, 1,240 ng/L, and 124 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure in *n*-nitrosodibutylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are

64 ng/L, 6.4 ng/L, and .64 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 5,888 ng/L, 587 ng/L, and 58.7 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure in *n*-nitrosodiphenylamine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 49,000 ng/L, 4,900 ng/L, and 490 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 161,000 ng/L, 16,100 ng/L, and 1,610 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

For the maximum protection of human health from the potential carcinogenic effects due to exposure in *n*-nitrosopyrrolidine through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk, over the lifetimes are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 160 ng/L, 16.0 ng/L, and 1.60 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 919,000 ng/L, 91,900 ng/L, and 9,190 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

*Pentachlorophenol**Freshwater Aquatic Life*

The available data for pentachlorophenol indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 55 and 3.2 μ g/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for pentachlorophenol indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 55 and 34 μ g/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for pentachlorophenol. Based on available toxicity data, for the protection of public health, the derived level is 1.01 mg/l. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 30 μ g/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

*Phenol**Freshwater Aquatic Life*

The available data for phenol indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 10,200 and 2,560 μ g/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for phenol indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 5,800 μ g/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of phenol to sensitive saltwater aquatic life.

Human Health

For comparison purposes, two approaches were used to derive criterion levels for phenol. Based on available toxicity data, for the protection of public health, the derived level is 3.5 mg/l. Using available organoleptic data, for controlling

undesirable taste and odor quality of ambient water, the estimated level is 0.3 mg/L. It should be recognized that organoleptic data as a basis for establishing a water quality criterion have limitations and have no demonstrated relationship to potential adverse human health effects.

Phthalate Esters

Freshwater Aquatic Life

The available data for phthalate esters indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 940 and 3 µg/L respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for phthalate esters indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2944 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of phthalate esters to sensitive saltwater aquatic life but toxicity to one species of algae occurs at concentrations as low as 3.4 µg/L.

Human Health

For the protection of human health from the toxic properties of dimethyl-phthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 313 mg/L.

For the protection of human health from the toxic properties of dimethyl-phthalate ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 2.9 g/L.

For the protection of human health from the toxic properties of diethyl-phthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 350 mg/L.

For the protection of human health from the toxic properties of diethyl-phthalate ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 1.8 g/L.

For the protection of human health from the toxic properties of dibutyl-phthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 34 mg/L.

For the protection of human health from the toxic properties of dibutyl-phthalate ingested through

contaminated aquatic organisms alone, the ambient water criterion is determined to be 154 mg/L.

For the protection of human health from the toxic properties of di-2-ethylhexyl-phthalate ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 15 mg/L.

For the protection of human health from the toxic properties of di-2-ethylhexyl-phthalate ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 50 mg/L.

Polychlorinated Biphenyls

Freshwater Aquatic Life

For polychlorinated biphenyls the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.014 µg/L as a 24-hour average. The available data indicate that acute toxicity to freshwater aquatic life probably will only occur at concentrations above 20 µg/L and that the 24-hour average should provide adequate protection against acute toxicity.

Saltwater Aquatic Life

For polychlorinated biphenyls the criterion to protect saltwater aquatic life as derived using the Guidelines is 0.030 µg/L as a 24-hour average. The available data indicate that acute toxicity to saltwater aquatic life probably will only occur at concentrations above 10 µg/L and that the 24-hour average should provide adequate protection against acute toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of PCBs through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5} , 10^{-6} , and 10^{-7} . The corresponding criteria are 79 ng/L, 0.79 ng/L, and 0.079 ng/L respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 79 ng/L, 0.79 ng/L, and 0.079 ng/L respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not

represent an Agency judgment on an "acceptable" risk level.

Polynuclear Aromatic Hydrocarbons (PAHs)

Freshwater Aquatic Life

The limited freshwater data base available for polynuclear aromatic hydrocarbons, mostly from short-term bioconcentration studies with two compounds, does not permit a statement concerning acute or chronic toxicity.

Saltwater Aquatic Life

The available data for polynuclear aromatic hydrocarbons indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 0.1 µg/L and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of polynuclear aromatic hydrocarbons to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of PAHs through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5} , 10^{-6} , and 10^{-7} . The corresponding criteria are 28 ng/L, 2.8 ng/L, and 0.28 ng/L, respectively. If the above estimates are made for consumption of aquatic organisms or excluding consumption of water, the levels are 311 ng/L, 31.1 ng/L, and 3.11 ng/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Selenium

Freshwater Aquatic Life

For total recoverable inorganic selenite the criterion to protect freshwater aquatic life as derived using the Guidelines is 95 µg/L as a 24-hour average and the concentration should not exceed 260 µg/L at any time.

The available data for inorganic selenate indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 760 µg/L and would occur at lower concentrations among species that are more sensitive

than those tested. No data are available concerning the chronic toxicity of inorganic selenate to sensitive freshwater aquatic life.

Saltwater Aquatic Life

For total recoverable inorganic selenite the criterion to protect saltwater aquatic life as derived using the Guidelines is 54 µg/l as a 24-hour average and the concentration should not exceed 410 µg/l at any time.

No data are available concerning the toxicity of inorganic selenate to saltwater aquatic life.

Human Health

The ambient water quality criterion for selenium is recommended to be identical to the existing drinking water standard which is 10 µg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from consumption of 6.5 grams of aquatic organisms was not derived.

Silver

Freshwater Aquatic Life

For freshwater aquatic life the concentration (in µg/l) of total recoverable silver should not exceed the numerical value given by " $e^{[1.72(\ln(\text{hardness}) - 6.52)]}$ " at any time. For example, at hardnesses of 50, 100, 200 mg/l as CaCO₃ the concentration of total recoverable silver should not exceed 1.2, 4.1, and 13 µg/l, respectively, at any time. The available data indicate that chronic toxicity to freshwater aquatic life may occur at concentrations as low as 0.12 µg/l.

Saltwater Aquatic Life

For saltwater aquatic life the concentration of total recoverable silver should not exceed 2.3 µg/l at any time. No data are available concerning the chronic toxicity of silver to sensitive saltwater aquatic life.

Human Health

The ambient water quality criterion for silver is recommended to be identical to the existing drinking water standard which is 50 µg/L. Analysis of the toxic effects data resulted in a calculated level which is protective of human health against the ingestion of contaminated water and contaminated aquatic organisms. The calculated value is comparable to the present standard. For this reason a selective criterion based on exposure solely from

consumption of 6.5 grams of aquatic organisms was not derived.

Tetrachloroethylene

Freshwater Aquatic Life

The available data for tetrachloroethylene indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 5,280 and 840 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Saltwater Aquatic Life

The available data for tetrachloroethylene indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations low as 10,200 and 450 µg/L, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of tetrachloroethylene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 8 µg/L, 8 µg/L, and 0.8 µg/L, respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 88.5 µg/L, 8.85 µg/L, and .88 µg/L, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Thallium

Freshwater Aquatic Life

The available data for thallium indicate that acute and chronic toxicity to freshwater aquatic life occur at concentrations as low as 1,400 and 40 µg/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested. Toxicity to one species of fish occurs at concentrations as low as 20 µg/l after 2,600 hours of exposure.

Saltwater Aquatic Life

The available data for thallium indicate that acute toxicity to saltwater

aquatic life occurs at concentrations as low as 2,130 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of thallium to sensitive saltwater aquatic life.

Human Health

For the protection of human health from the toxic properties of thallium ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 13 µg/L.

For the protection of human health from the toxic properties of thallium ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 48 µg/L.

Toluene

Freshwater Aquatic Life

The available data for toluene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 17,500 µg/l and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of toluene to sensitive freshwater aquatic life.

Saltwater Aquatic Life

The available data for toluene indicate that acute and chronic toxicity to saltwater aquatic life occur at concentrations as low as 6,300 and 500 µg/l, respectively, and would occur at lower concentrations among species that are more sensitive than those tested.

Human Health

For the protection of human health from the toxic properties of toluene ingested through water and contaminated aquatic organisms, the ambient water criterion is determined to be 14.3 mg/L.

For the protection of human health from the toxic properties of toluene ingested through contaminated aquatic organisms alone, the ambient water criterion is determined to be 424 mg/l.

Toxaphene

Freshwater Aquatic Life

For toxaphene the criterion to protect freshwater aquatic life as derived using the Guidelines is 0.013 µg/l as a 24-hour average and the concentration should not exceed 1.8 µg/l at any time.

Saltwater Aquatic Life

For saltwater aquatic life the concentration of toxaphene should not exceed 0.070 µg/l at any time. No data

are available concerning the chronic toxicity of toxaphene to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of toxaphene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 27 $\mu\text{g/L}$, 27 $\mu\text{g/L}$, and 27 $\mu\text{g/L}$ respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 807 $\mu\text{g/L}$, 80.7 $\mu\text{g/L}$, and 8.07 $\mu\text{g/L}$, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Trichloroethylene

Freshwater Aquatic Life

The available data for trichloroethylene indicate that acute toxicity to freshwater aquatic life occurs at concentrations as low as 45,000 $\mu\text{g/L}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trichloroethylene to sensitive freshwater aquatic life but adverse behavioral effects occurs to one species at concentrations as low as 21,900 $\mu\text{g/L}$.

Saltwater Aquatic Life

The available data for trichloroethylene indicate that acute toxicity to saltwater aquatic life occurs at concentrations as low as 2,000 $\mu\text{g/L}$ and would occur at lower concentrations among species that are more sensitive than those tested. No data are available concerning the chronic toxicity of trichloroethylene to sensitive saltwater aquatic life.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of trichloroethylene through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on

the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 27 $\mu\text{g/L}$, 27 $\mu\text{g/L}$, and 27 $\mu\text{g/L}$ respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 807 $\mu\text{g/L}$, 80.7 $\mu\text{g/L}$, and 8.07 $\mu\text{g/L}$, respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Vinyl Chloride

Freshwater Aquatic Life

No freshwater organisms have been tested with vinyl chloride and no statement can be made concerning acute or chronic toxicity.

Saltwater Aquatic Life

No saltwater organisms have been tested with vinyl chloride and no statement can be made concerning acute or chronic toxicity.

Human Health

For the maximum protection of human health from the potential carcinogenic effects due to exposure of vinyl chloride through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-6} , 10^{-5} , and 10^{-4} . The corresponding criteria are 20 $\mu\text{g/L}$, 2.0 $\mu\text{g/L}$, and 0.2 $\mu\text{g/L}$ respectively. If the above estimates are made for consumption of aquatic organisms only, excluding consumption of water, the levels are 5,246 $\mu\text{g/L}$, 525 $\mu\text{g/L}$, and 52.5 $\mu\text{g/L}$ respectively. Other concentrations representing different risk levels may be calculated by use of the Guidelines. The risk estimate range is presented for information purposes and does not represent an Agency judgment on an "acceptable" risk level.

Zinc

Freshwater Aquatic Life

For total recoverable zinc the criterion to protect freshwater aquatic life as derived using the Guidelines is 47 $\mu\text{g/L}$ as a 24-hour average and the concentration (in $\mu\text{g/L}$) should not

exceed the numerical value given by $(10 \times \text{hardness})^{0.5} + 100$ at any time. For example, at hardnesses of 50, 100, or 200 mg/L as CaCO_3 , the concentration total recoverable zinc should not exceed 180, 320, and 570 $\mu\text{g/L}$ at any time.

Saltwater Aquatic Life

For total recoverable zinc the criterion to protect saltwater aquatic life as derived using the Guidelines is 58 μg as a 24-hour average and the concentration should not exceed 170 $\mu\text{g/L}$ at any time.

Human Health

Sufficient data is not available for zinc to derive a level which would protect against the potential toxicity of this compound. Using available organoleptic data, for controlling undesirable taste and odor quality of ambient water, the estimated level is 100 mg/L . It should be recognized that organoleptic data as a basis for establishing a water quality criteria have limitations and have not demonstrated relationship to potential adverse human health effects.

Appendix B—Guidelines for Deriving Water Quality Criteria for the Protection of Aquatic Life and Its Uses

Introduction

This version of the Guidelines provides clarifications, additional details, and technical and editorial changes in the last version published in the Federal Register [44 FR 19970 (Oct. 15, 1979)]. This version incorporates changes resulting from comments on previous versions and from experience gained during U.S. EPA's use of the previous versions. Future versions of the Guidelines will incorporate new information and data as their usefulness is demonstrated.

Criteria may be expressed in several forms. The numerical form is commonly used, but descriptive and procedural forms can be used if numerical criteria are not possible or desirable. The purpose of these Guidelines is to describe an objective, internally consistent and appropriate way of deriving numerical water quality criteria for the protection of the uses of, as well as the presence of, aquatic organisms.

A numerical criterion might be thought of as an estimate of the highest concentration of a substance in water which does not present a significant hazard to the aquatic organisms in the water and their uses. Thus the Guidelines are intended to derive criteria which will protect aquatic communities by protecting most of the species and uses most of the time, but not

OK

SUMMARY

SNARLS

Assumptions:

1. Looking at sensitive population.
2. Using a child weighing 10 kg. who drinks one liter of water per day.
3. Considering only toxic effects.

Compound

Length of Exposure

	<u>1 day</u>	<u>7 days</u>	<u>10 days</u>	<u>1 month</u>	<u>life-time</u>
trichloroethylene	2 mg/l		200 ug/l		75 ug/l
tetrachloroethylene	2.3 mg/l		180 ug/l		40 ug/l
1,1,1-trichloroethane					1 mg/l
benzene		350 ug/l			
polynuclear aromatic hydrocarbons		25 ug/l			

Cancer Risks

Assumptions:

1. There is some risk at any level of exposure, and the risk increases as lifetime exposure increases.
2. Using 70 kg. adult living 70 years who drinks two liters of water per day.

Compound

Excess Risk

	<u>One in 10⁻⁶</u>	<u>One in 10⁻⁵</u>	<u>Two in 10⁻⁵</u>	<u>Six in 10⁻⁶</u>
trichloroethylene	4.5 ug/l	45 ug/l	75 ug/l	
tetrachloroethylene	3.5 ug/l	35 ug/l		20 ug/l

Draft SNARLS (not to be released)

Assumptions:

1. Looking at sensitive population.
2. Using a child weighing 10 kg. who drinks one liter of water per day.
3. Considering only toxic effects. .

<u>Compound</u>	<u>Length of Exposure</u>				
	<u>1 day</u>	<u>7 days</u>	<u>10 days</u>	<u>1 month</u>	<u>life-time</u>
methylene chloride	13 mg/l		1.3-1.5 mg/l		150 ug/l
carbon tetrachloride	200 ug/l		20 ug/l		-
toluene			1 mg/l		
methyl ethyl ketone			1 mg/l		
acrylonitrile			35 ug/l	3 ug/l	
polychlorinated biphenyls				1 ug/l	0.3 ug/l
dibromochloropropane					0.05 ug/l
1,4-dioxane			20 ug/l		
xylene	12 mg/l		1.4 mg/l		620 ug/l
chlordane	63 ug/l		63 ug/l		8 ug/l
1,1 Dichloroethylene	1.0 mg/l				70 ug/l
Trans-1,2 Dichloroethylene	2.7 mg/l		0.27 mg/l		
Cis-1,2 Dichloroethylene	4.0 mg/l		0.40 mg/l		
Ethylene Glycol	19 mg/l				5.5 mg/l

SNARL For Trichloroethylene
Health Effects Branch, Criteria and Standards Division
Office of Drinking Water
U.S. Environmental Protection Agency
Washington, D.C. 20460

The Office of Drinking Water has reviewed the current literature on the health effects of trichloroethylene. Both data from animal tests and some studies from high level exposure in humans were used as basis for extrapolating to levels in drinking water that would result in negligible risks to the general human population. When considering toxicity that does not include the risk of cancer, we generally use a child weighing 10 kg (22 pounds) and drinking one liter of water per day as the basis for calculations of short exposure (acute) toxicity and longer exposure (chronic) toxicity. These levels are derived using safety factors from classical toxicology and a logic similar to that used by the National Academy of Sciences in "Drinking Water and Health." When considering the possible cancer risk, where it is assumed that there is some risk at any level of exposure, and that the risk increases as the lifetime exposure increases, we use the 70 kg (154 pounds) adult living 70 years who drinks two liters of water as the base, and calculate the excess cancer risk above the normal background according to a mathematical model developed by the National Academy of Sciences in "Drinking Water and Health," and based on animal tests conducted by the National Cancer Institute.

The drinking water levels that we have calculated providing a margin of safety from likely toxic effects in humans (assuming that 100% of the exposure is from drinking water) were related to the length of time that water is being consumed, and range from short-term emergency levels to long-term chronic exposure. We have separately computed the potential additional cancer risk.

The computed drinking water guidance levels for effects excluding cancer risks are as follows:

<u>Time</u>	<u>Concentration</u>
1 day	2 mg/l
10 days	0.2 mg/l (200 ug/l)
Chronic (long-term)	75 ug/l

The computed excess lifetime cancer risks from the NAS model at various exposures assuming the 70 kg adult drinking two liters of water per day for 70 years at the indicated concentration are as follows:

<u>Concentration</u>	<u>Excess Risk</u>
4.5 ug/l	one in 1,000,000
45 ug/l	one in 100,000
75 ug/l	approximately two in 100,000

The development of a SNARL for trichloroethylene does not condone its presence in drinking water, but rather provides useful information to guide control priorities in cases where it is found as a contaminant. Human exposure to contaminants in drinking water such as trichloroethylene should be reduced to the extent feasible, to avoid the unnecessary risks from their presence as adulterants. The applicable treatment technologies include aeration and granular activated carbon.